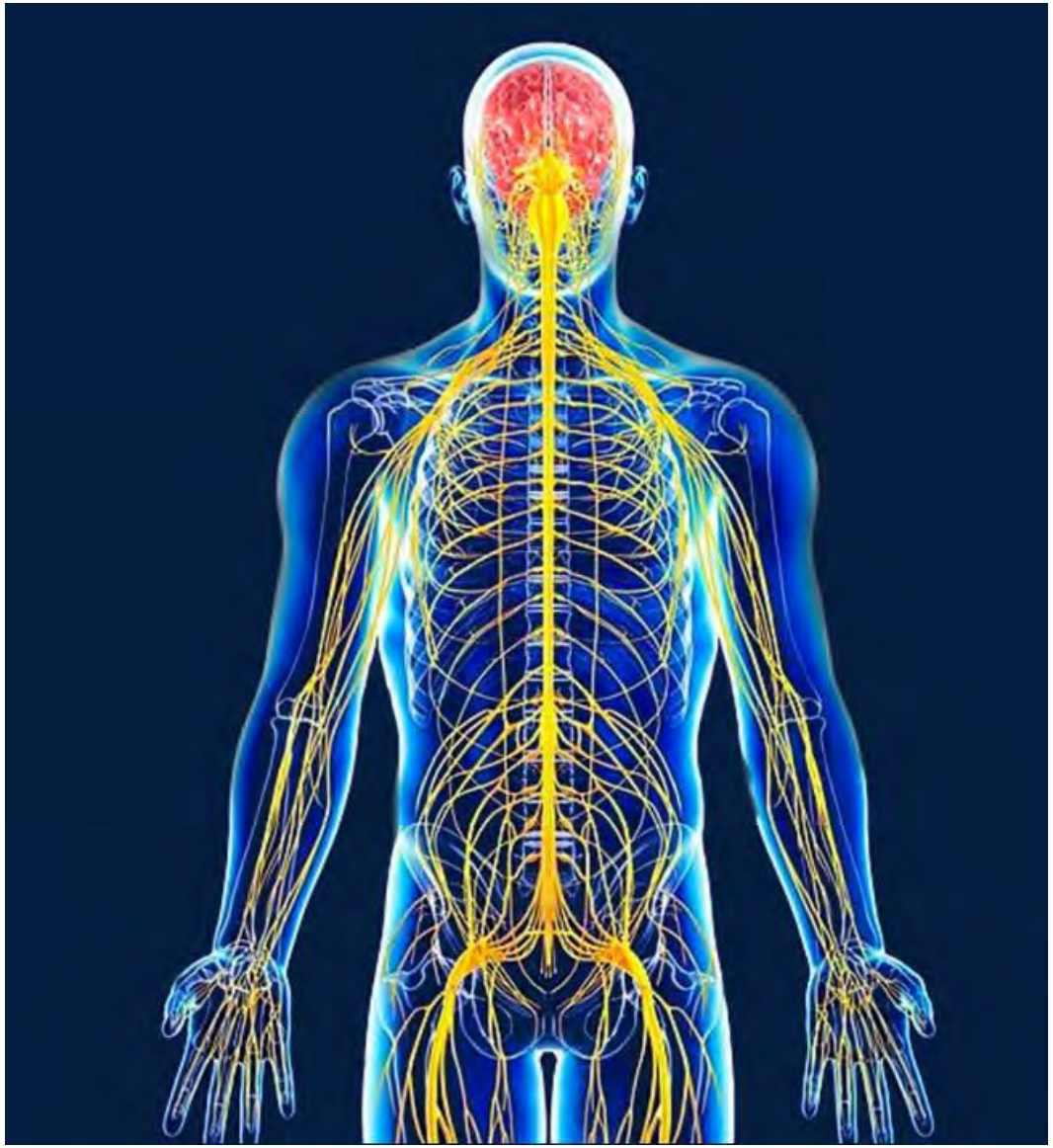
THE NERVOUS SYSTEM



COMPILED BY HOWIE BAUM

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THE NERVOUS SYSTEM

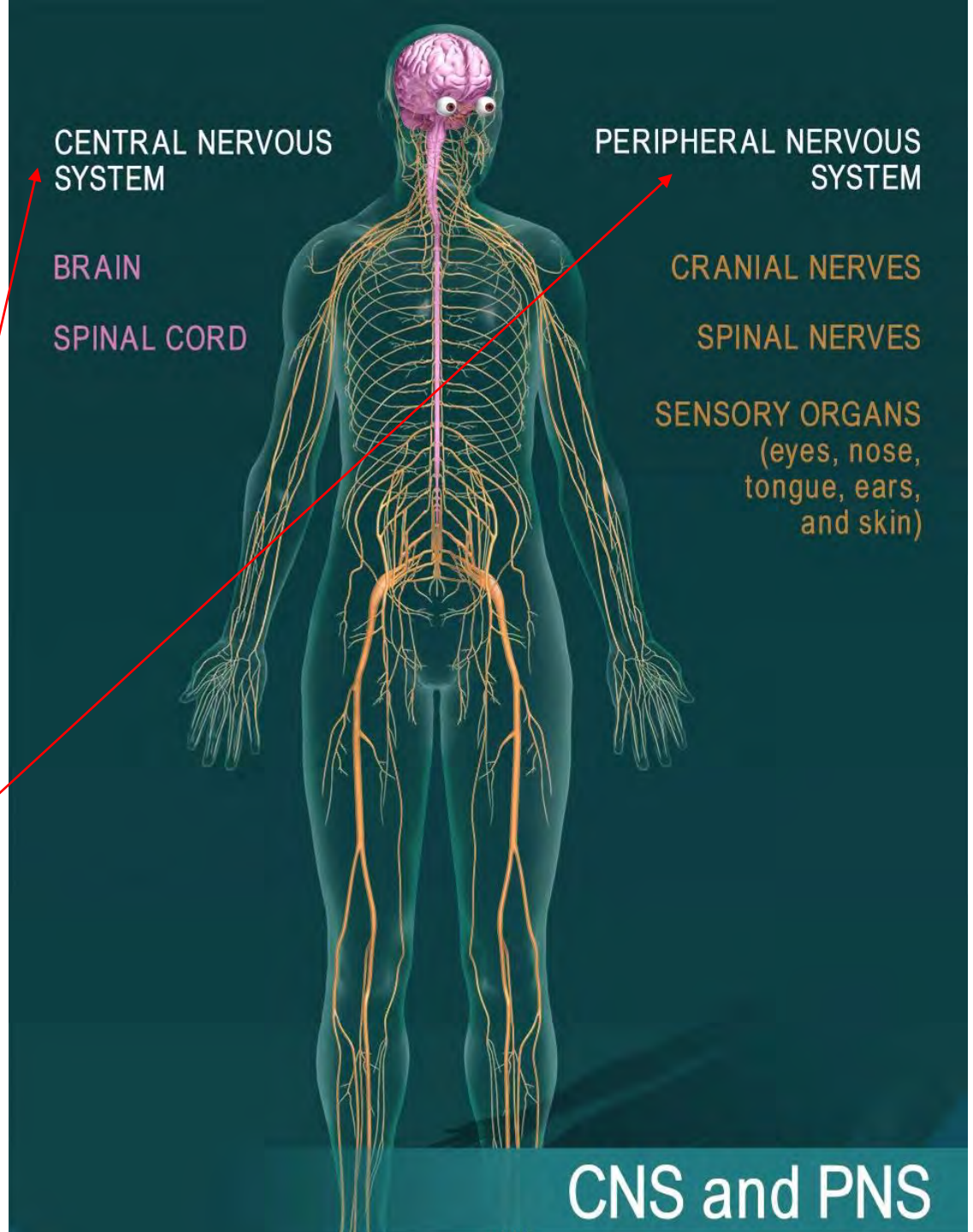
The nervous system is the most complex body system !!

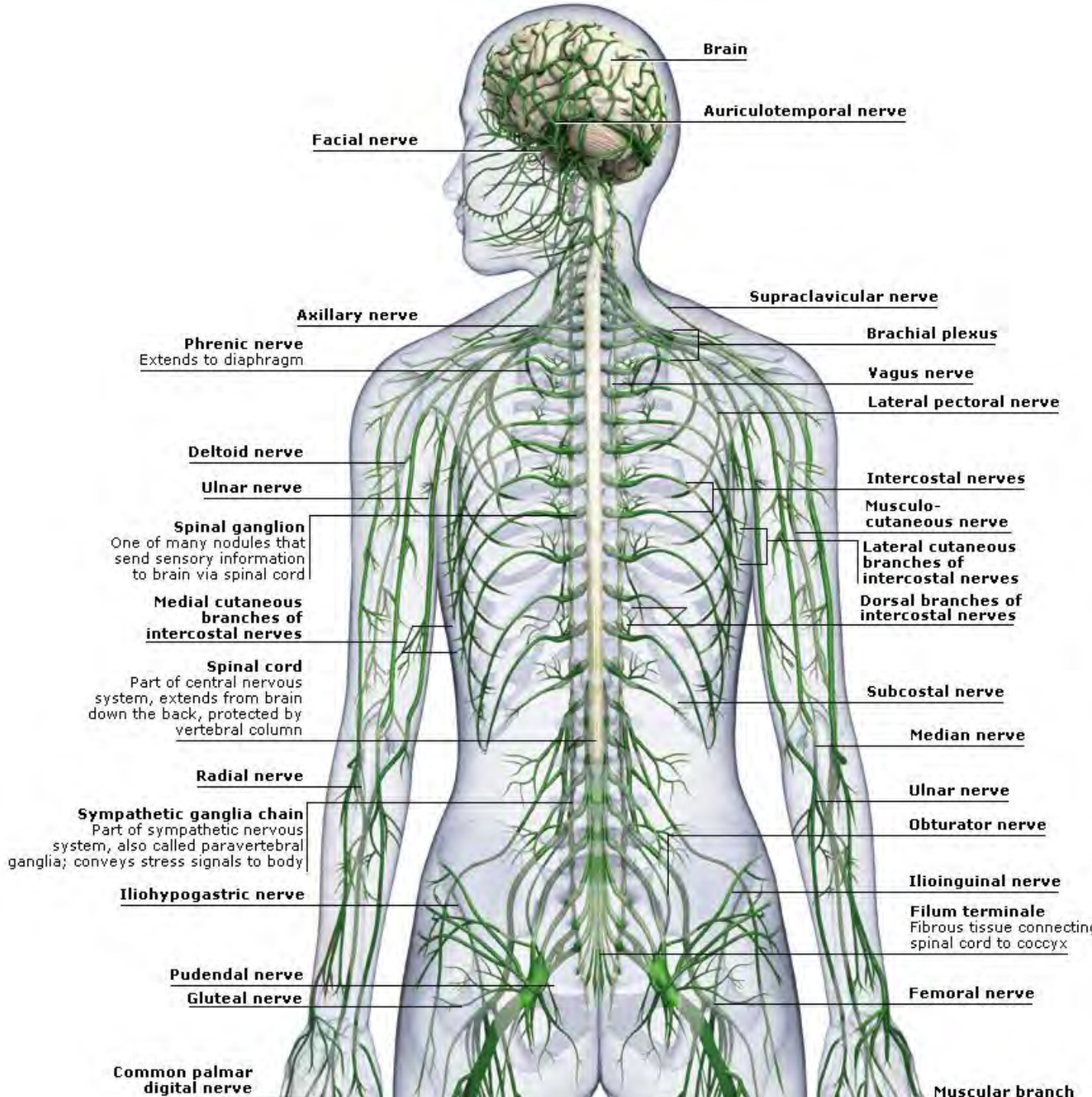
Constantly alive with electricity, the nervous system is the body's prime communication and coordination network.

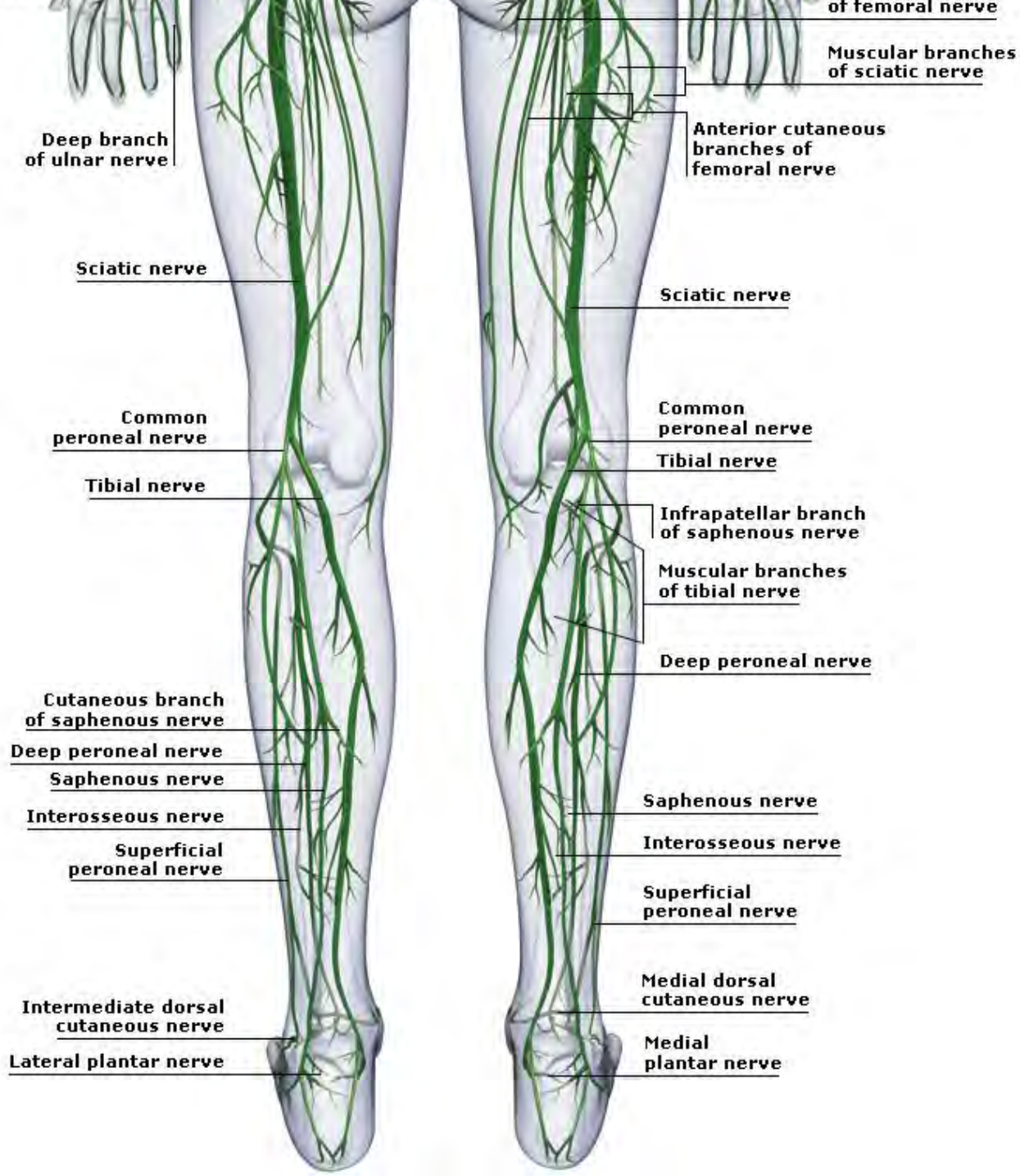
It is so vast and complex that, an estimate is that all the individual nerves from one body, joined end to end, could reach around the world two and a half times.

The Brain and Spinal Cord are the Central Nervous System.

Nerves and Sensory Organs Make Up the Peripheral Nervous System.




Brain
Auriculotemporal nerve
Facial nerve
Supraclavicular nerve
Axillary nerve
Brachial plexus
Phrenic nerve
Extends to diaphragm
Vagus nerve
Lateral pectoral nerve
Deltoid nerve
Intercostal nerves
Ulnar nerve
Musculo-cutaneous nerve
Spinal ganglion
One of many nodules that send sensory information to brain via spinal cord
Lateral cutaneous branches of intercostal nerves
Medial cutaneous branches of intercostal nerves
Dorsal branches of intercostal nerves
Spinal cord
Part of central nervous system, extends from brain down the back, protected by vertebral column
Subcostal nerve
Median nerve
Radial nerve
Ulnar nerve
Sympathetic ganglia chain
Part of sympathetic nervous system, also called paravertebral ganglia; conveys stress signals to body
Obturator nerve
Ilioinguinal nerve
Iliohypogastric nerve
Filum terminale
Fibrous tissue connecting spinal cord to coccyx
Pudendal nerve
Femoral nerve
Gluteal nerve
Common palmar digital nerve
Muscular branch

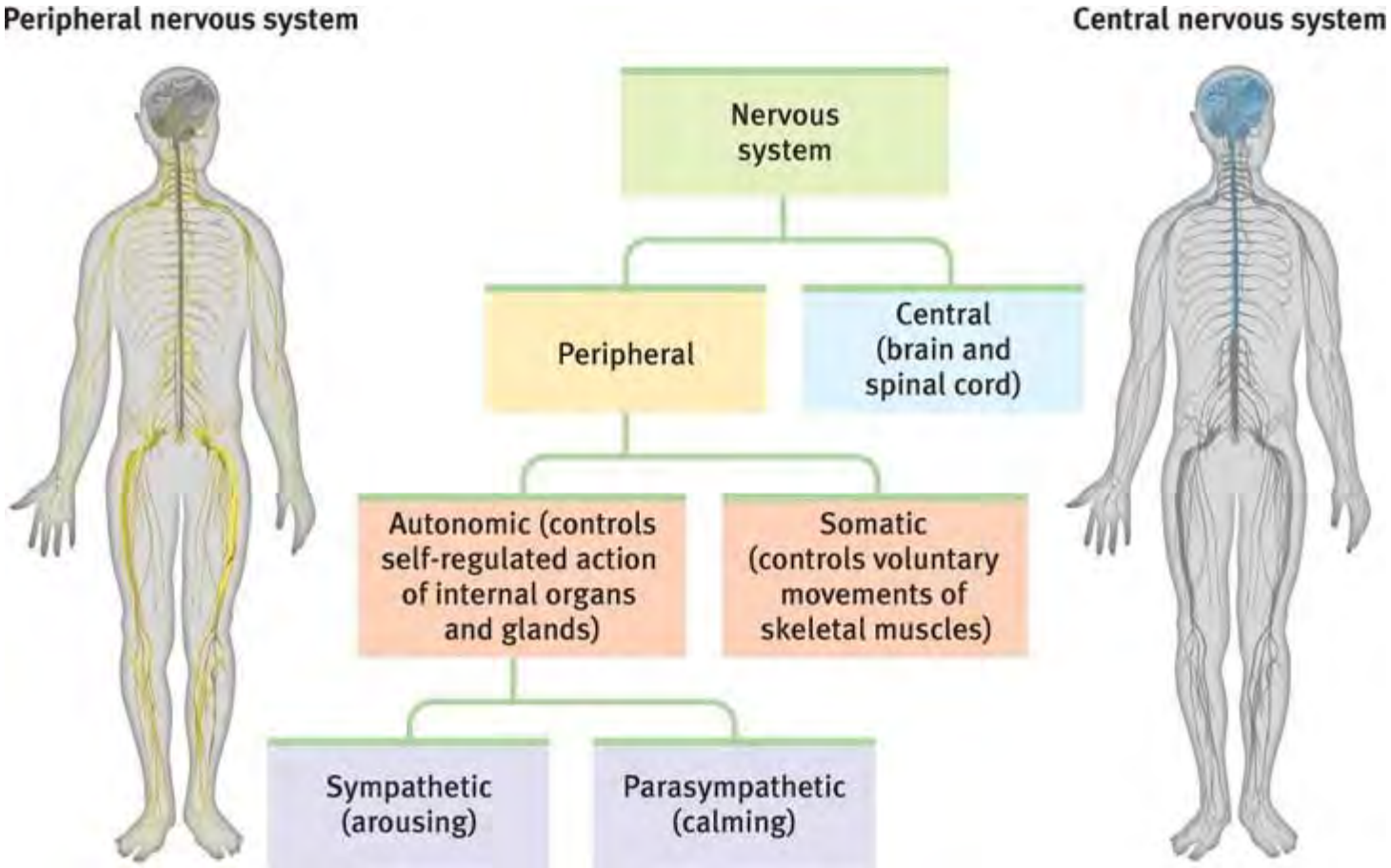

Deep branch of ulnar nerve
Sciatic nerve
Common peroneal nerve
Tibial nerve
Cutaneous branch of saphenous nerve
Deep peroneal nerve
Saphenous nerve
Interosseous nerve
Superficial peroneal nerve
Intermediate dorsal cutaneous nerve
Lateral plantar nerve
of femoral nerve
Muscular branches of sciatic nerve
Anterior cutaneous branches of femoral nerve
Sciatic nerve
Common peroneal nerve
Tibial nerve
Infrapatellar branch of saphenous nerve
Muscular branches of tibial nerve
Deep peroneal nerve
Saphenous nerve
Interosseous nerve
Superficial peroneal nerve
Medial dorsal cutaneous nerve
Medial plantar nerve

Together, the central nervous system (CNS) and the peripheral nervous systems (PNS) transmit and process sensory information and coordinate bodily functions.

The brain and spinal cord (the CNS) function as the control center.

They receive data and feedback from the sensory organs and from nerves throughout the body, process the information, and send commands back out.

Nerve pathways of the PNS carry the incoming and outgoing signals.



The Spinal Cord Transmits Signals to and from the Brain and Commands Reflexes

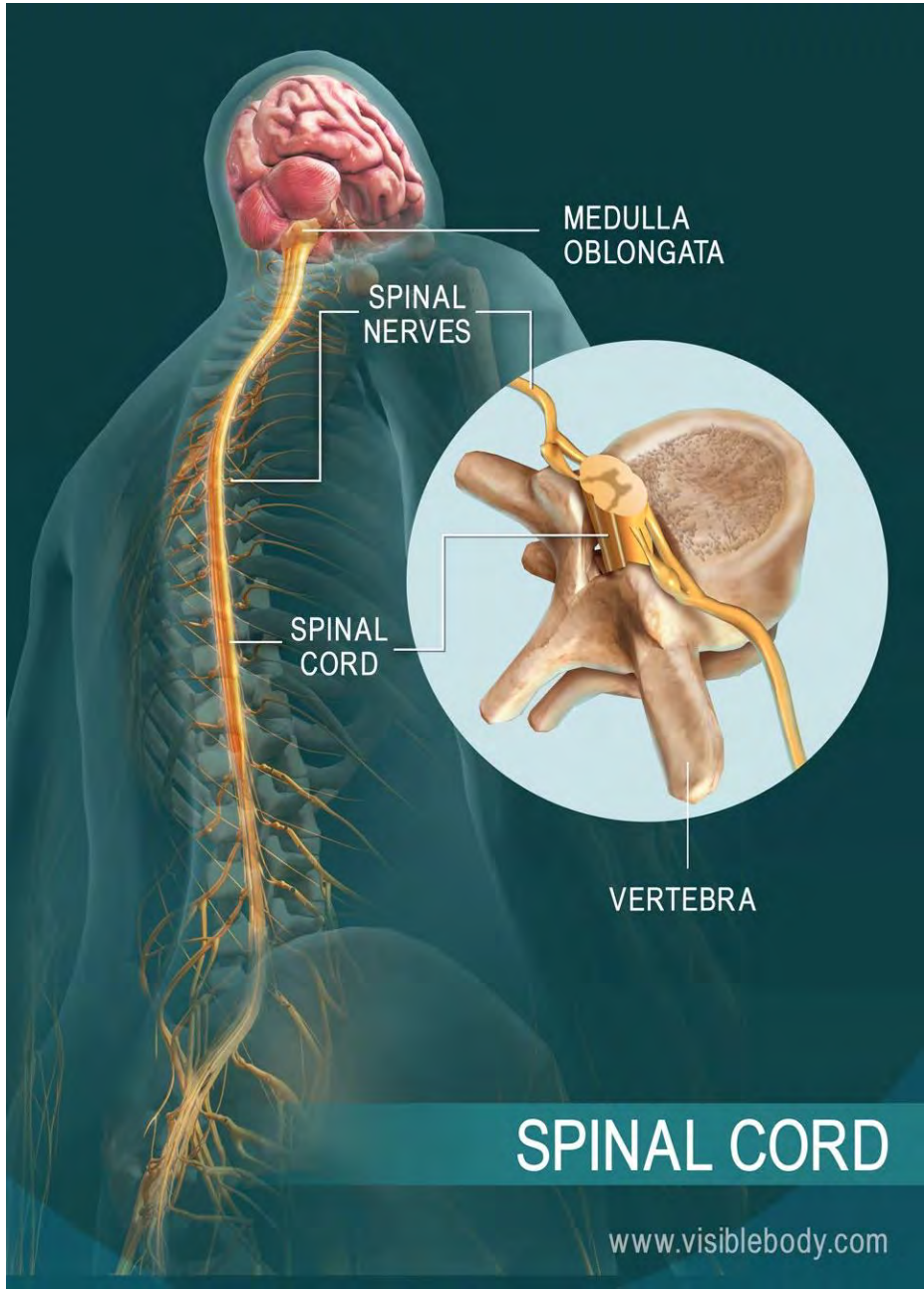
The spinal cord is an elongated cylinder of neuron cell bodies, bundles of axons and other cells, protected by connective tissue and bone.

It connects to the brain at the medulla oblongata and runs down the vertebral column, the hollow tunnel enclosed within the vertebrae of the spine.

The spinal cord is part of the central nervous system and serves as a kind of superhighway.

Sensory information and motor commands travel up and down, heading to and from the brain. These signals speed in and out of the spinal cord via spinal nerves—the "on-ramps and off-ramps" that branch out to supply the limbs, torso, and pelvis.

Some incoming signals demand a simple, immediate response. The spinal cord can shoot out a reflex command without bothering the brain, called a Reflex Arc.



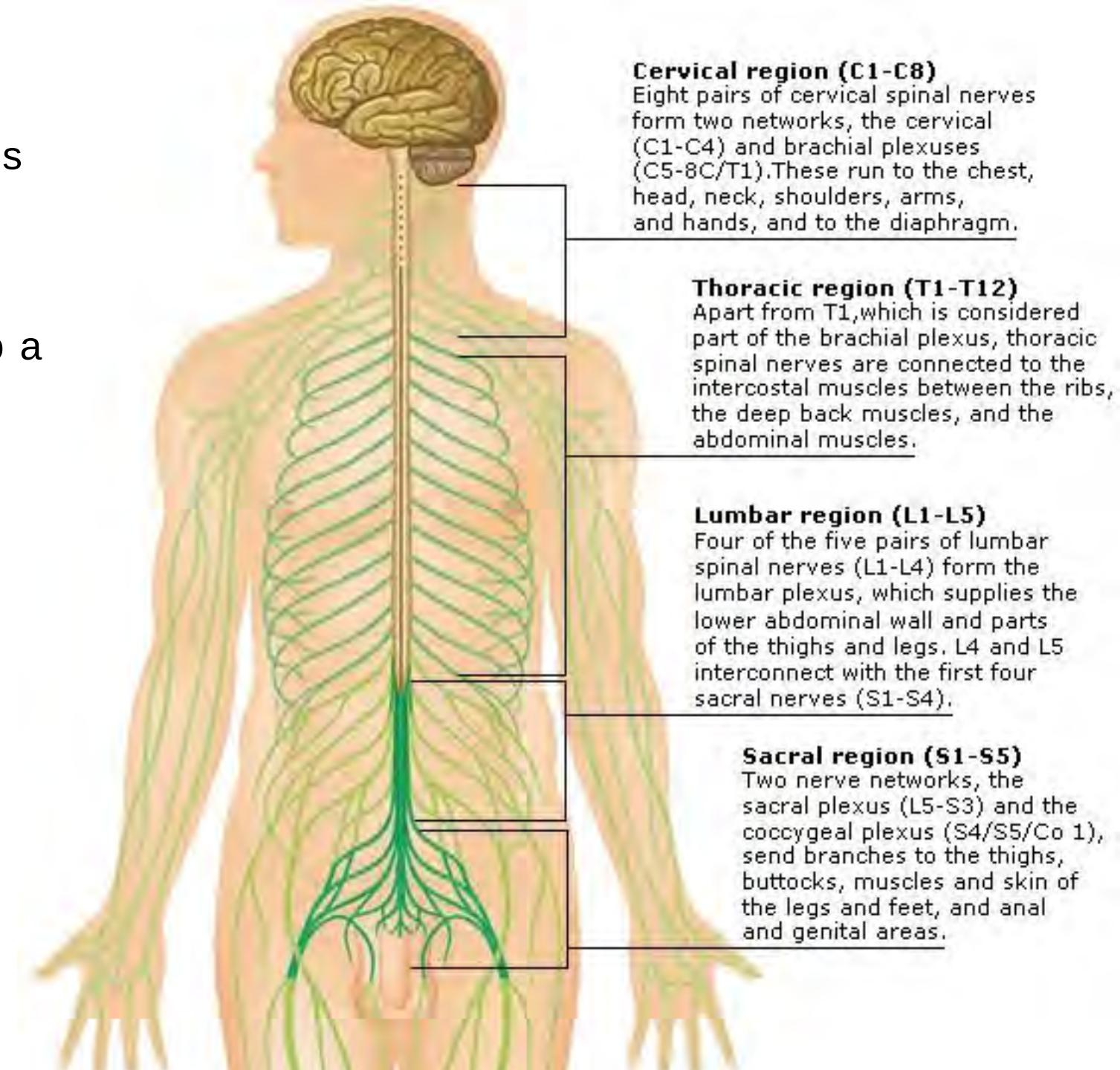
Spinal nerves

The 31 pairs of peripheral spinal nerves emerge from the spinal cord through spaces between the vertebrae.

Each nerve divides and subdivides into a number of branches; the dorsal branches serve the rear portion of the body, while the ventral serve the front and sides.

The branches of one spinal nerve may join with other nerves to form meshes called plexuses where information is shared.

The plexuses send signals along secondary nerve branches to areas of complex function or movement.


Cervical region (C1-C8)
Eight pairs of cervical spinal nerves form two networks, the cervical (C1-C4) and brachial plexuses (C5-8C/T1).These run to the chest, head, neck, shoulders, arms, and hands, and to the diaphragm.
Thoracic region (T1-T12)
Apart from T1,which is considered part of the brachial plexus, thoracic spinal nerves are connected to the intercostal muscles between the ribs, the deep back muscles, and the abdominal muscles.
Lumbar region (L1-L5)
Four of the five pairs of lumbar spinal nerves (L1-L4) form the lumbar plexus, which supplies the lower abdominal wall and parts of the thighs and legs. L4 and L5 interconnect with the first four sacral nerves (S1-S4).
Sacral region (S1-S5)
Two nerve networks, the sacral plexus (L5-S3) and the coccygeal plexus (S4/S5/Co 1), send branches to the thighs, buttocks, muscles and skin of the legs and feet, and anal and genital areas.

The Neurons of the Spinal Cord Form Neural Tracts

The long cylinder of the spinal cord consists mostly of bundles of axons that extend up and down to carry signals to or from the brain.

In a spinal cord cross-section, the axon pathways **appear as "white matter" (myelin sheaths make the axons white) surrounding the "gray matter" of the** neuron cell bodies.

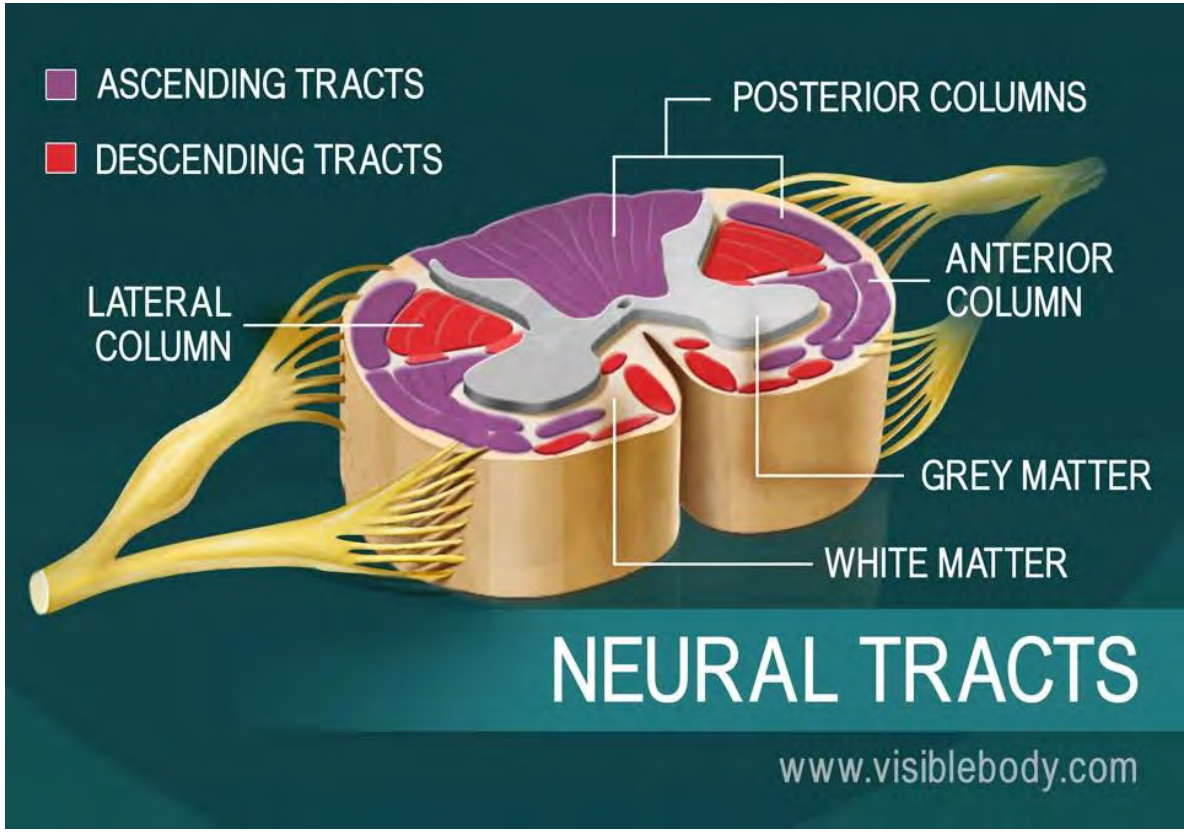
The white matter forms three columns (funiculi) on each side of the spinal cord: the posterior (dorsal), anterior (ventral), and lateral columns.

Distinct neural tracts run through these three columns.

Each tract consists of axons that carry similar types of signals in the same direction.

Ascending tracts carry sensory input up to the brain.

Descending tracts send motor commands downward to the body.



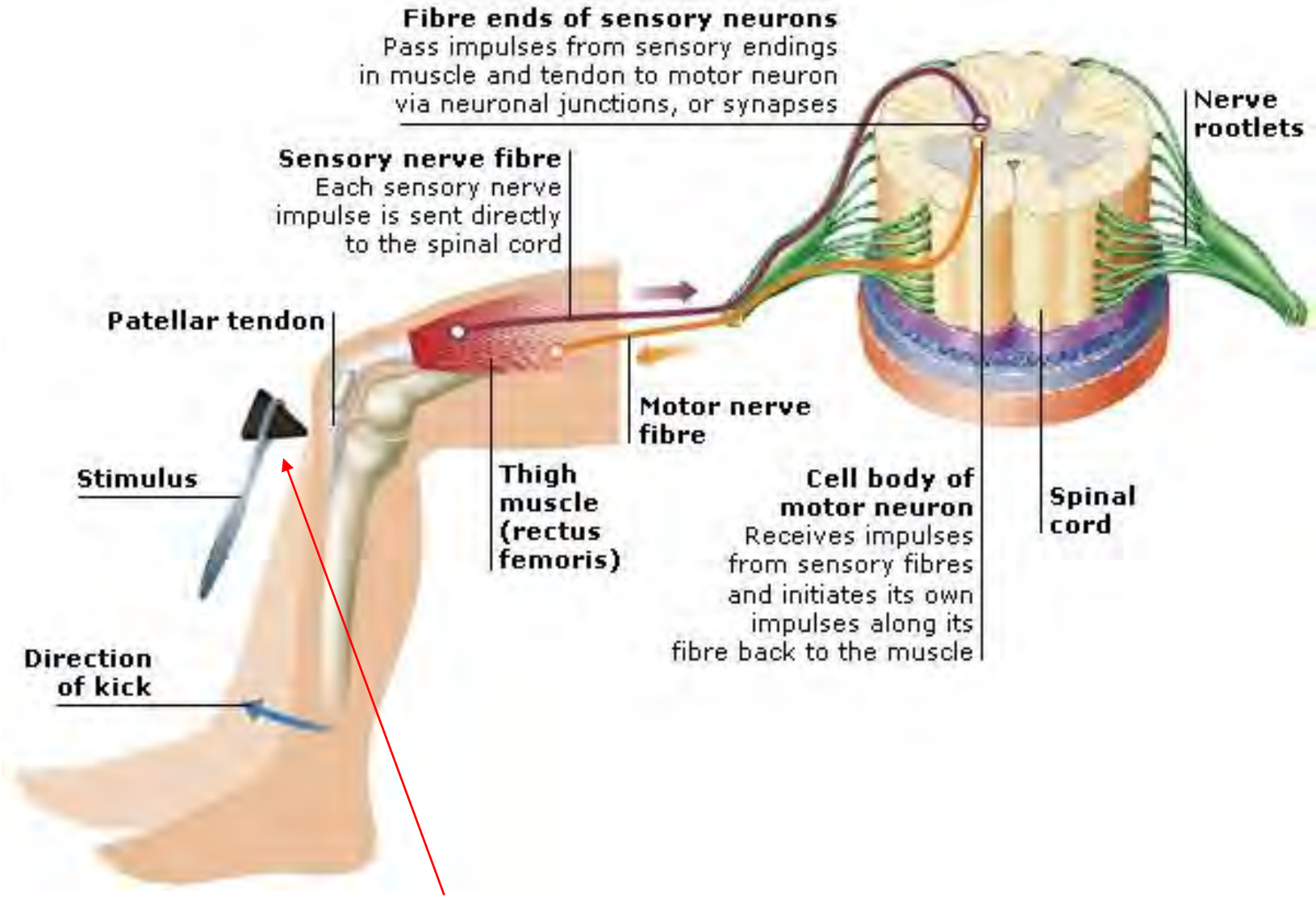
Spinal reflexes

A reflex is a rapid, involuntary, predictable response to a stimulus.

Most reflexes are concerned with survival and defending the body against damage and harm, such as coughing to remove irritants from the lower airways and sneezing to clear the nasal airways.

Spinal reflexes involve circuits of sensory nerve fibers that feed information to the spinal cord and then connect directly, or via an intermediate neuron, to motor nerve fibers, so that the resulting instructions for movement go directly out from the cord to the relevant muscles and not to the brain, to be activated.

This is called a Reflex Arc.


Fibre ends of sensory neurons
Pass impulses from sensory endings in muscle and tendon to motor neuron via neuronal junctions, or synapses
Nerve rootlets
Sensory nerve fibre
Each sensory nerve impulse is sent directly to the spinal cord
Patellar tendon
Motor nerve fibre
Stimulus
Thigh muscle (rectus femoris)
Cell body of motor neuron
Receives impulses from sensory fibres and initiates its own impulses along its fibre back to the muscle
Spinal cord
Direction of kick

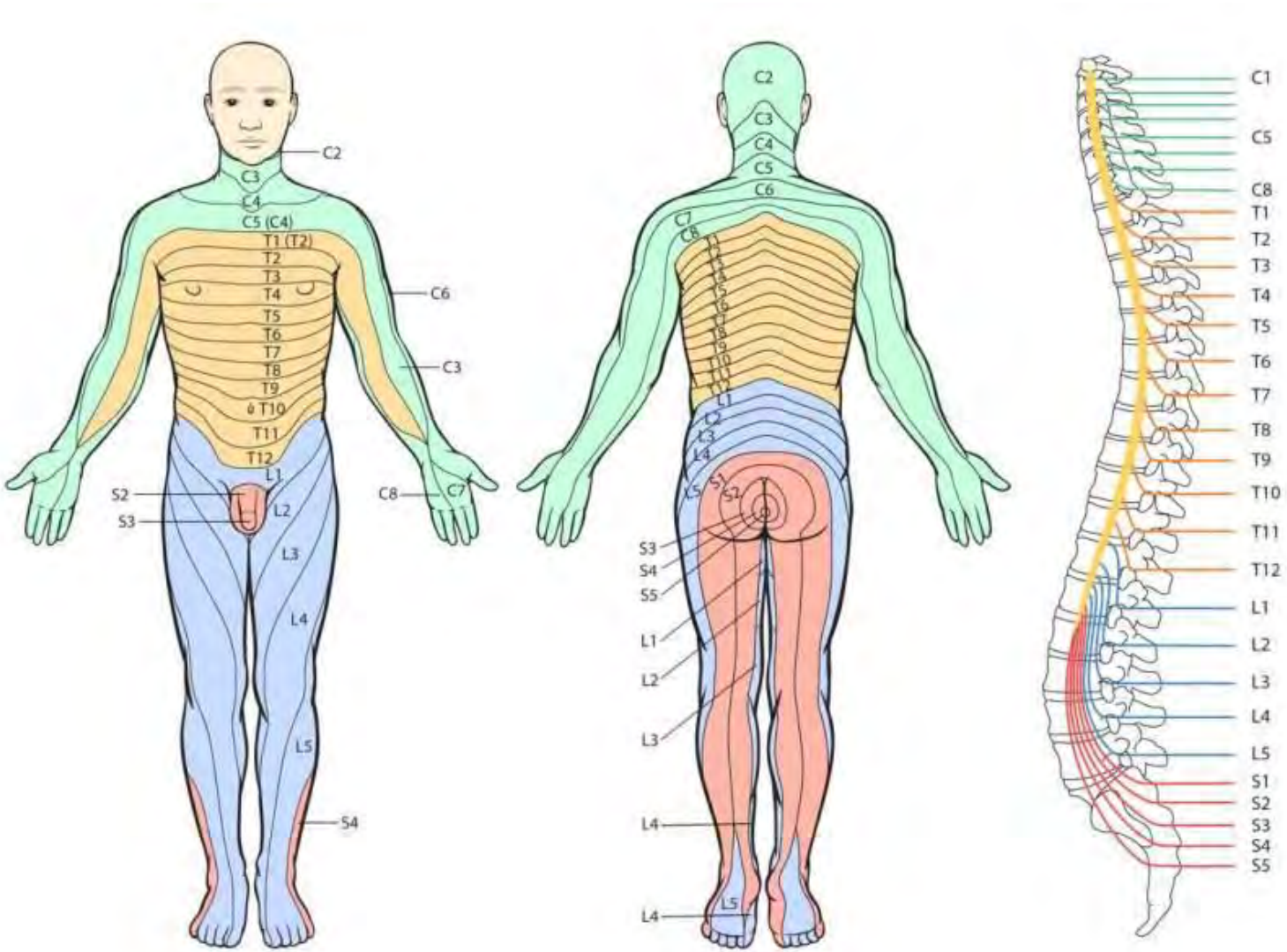
Tapping the patellar tendon below the kneecap stretches the front thigh muscle. This stimulates microsensors in the tendon and muscle that transmit nerve signals to the spinal cord. Motor nerve fibers relay signals straight back to the muscle, which contracts and causes a slight kick.

What Is a Dermatome?

A dermatome is the area of the skin of the human anatomy that is mainly supplied by branches of a single spinal sensory nerve root.

These spinal sensory nerves enter the nerve root at the spinal cord, and their branches reach to the outside areas of the body.

The sensory nerves in that area are a type of nerve that transmits signals from sensations (for example, pain symptoms, touch, temperature) to the spinal cord from specific areas of our anatomy.



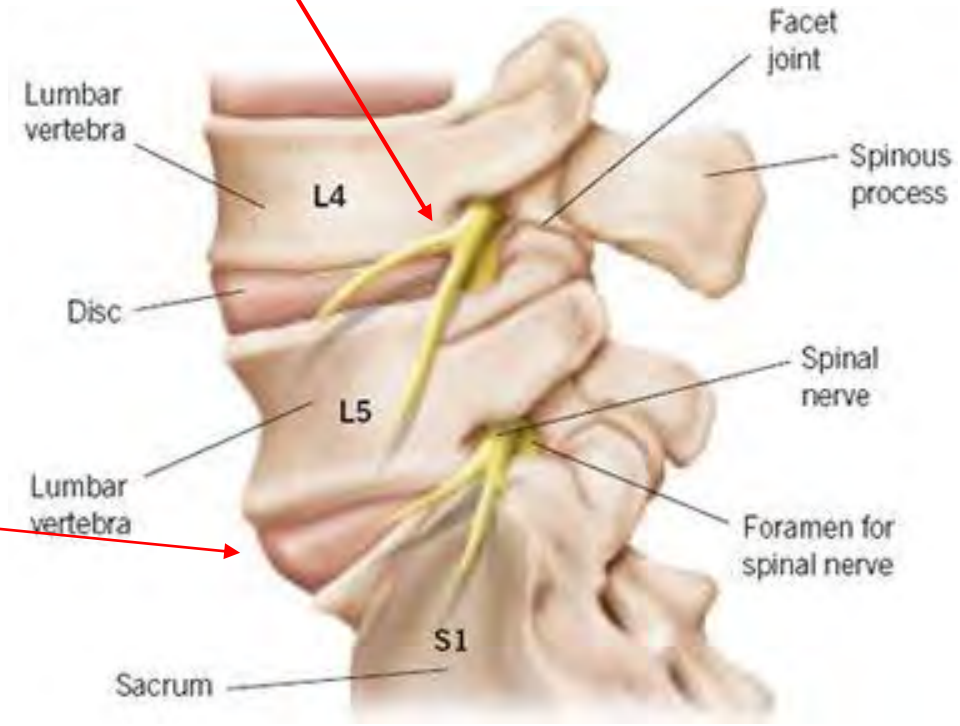
CAUSES OF SPINAL NERVE PAIN WHICH CAN CAUSE PAIN IN THE BODY WHERE THE NERVE GOES

All of the nerves (shown in yellow, below) come out from the Spinal column and go to the different parts of the body.

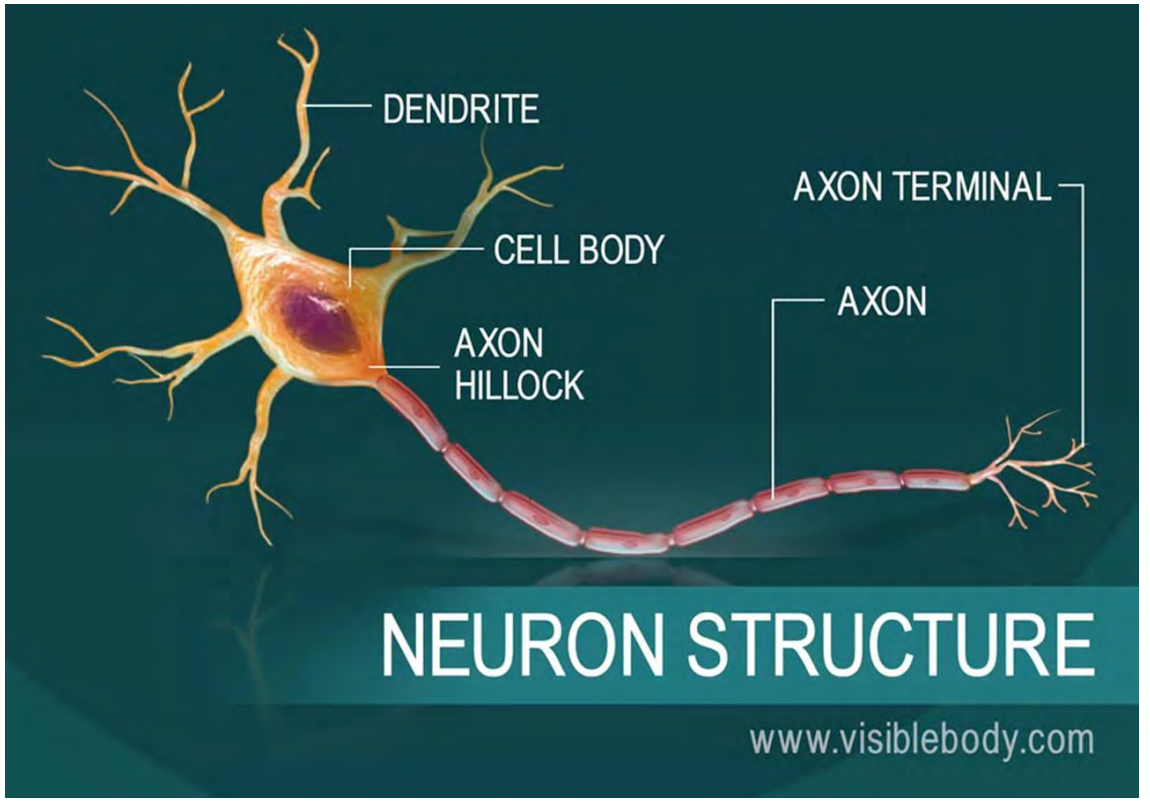
As people age, the jelly-like material between the discs can dry out which makes them thinner, letting the vertebrae move closer to each other. This is how they can start to pinch a nerve and cause pain where the nerve goes to.

The same thing can happen if a person does any extra heavy lifting and causes damage to a disc.

If a person lifts something too heavy that causes damage to the discs in the spine, the location is described with the letter and number of the 2 vertebrae involved such as L5 -S1.



Neurons in Nervous Tissue Relay Rapid-Fire Signals.



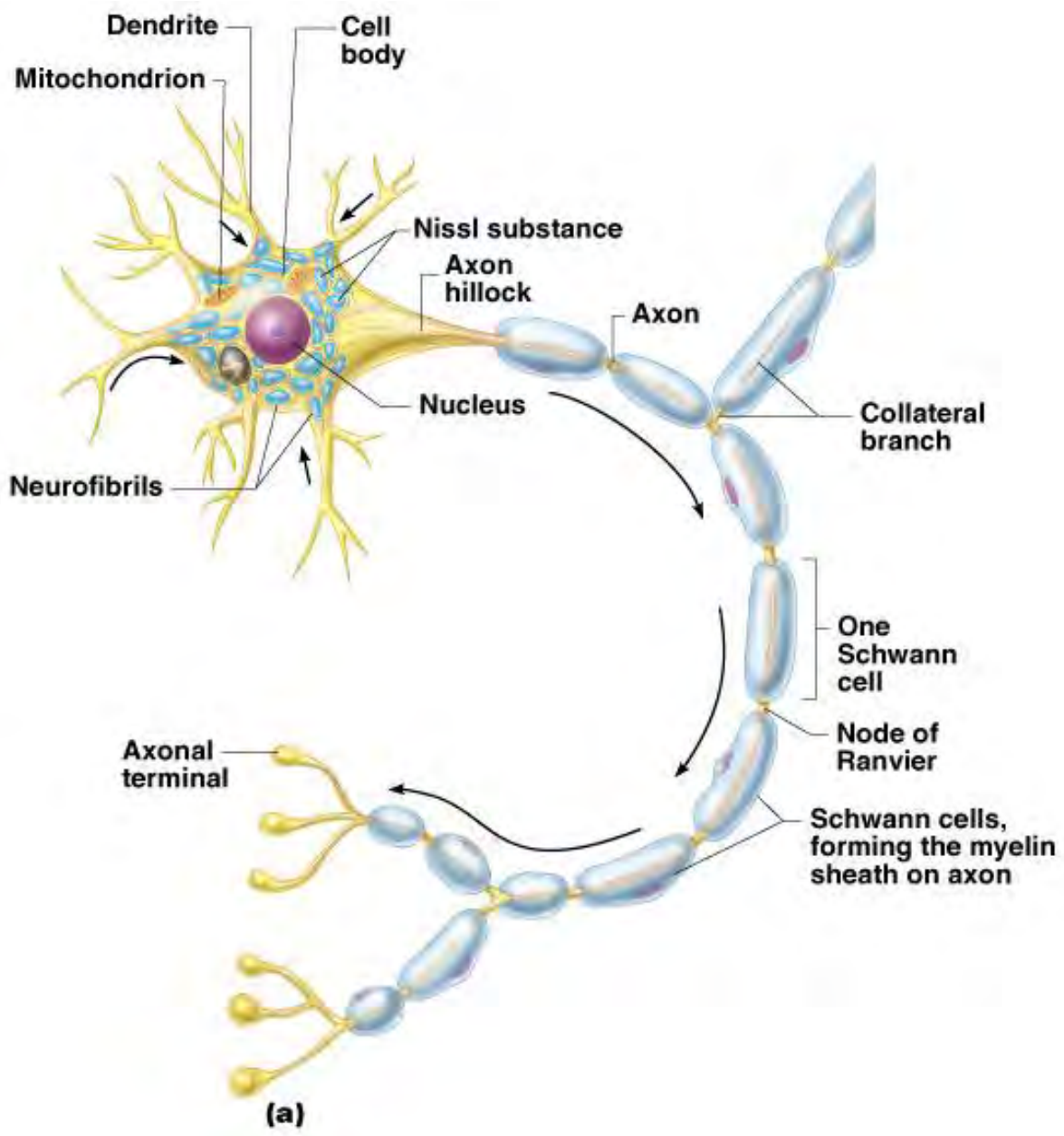
All nervous tissue, from the brain to the spinal cord to the furthest nerve branch, includes cells called neurons.

Neurons are charged cells: they conduct electrical signals to pass information through the body.

A typical neuron consists of a cell body, dendrites, and an axon with an axon terminal.

Neuron Anatomy

- Extensions outside the cell body
  - Dendrites – conduct impulses toward the cell body
  - Axons – conduct impulses away from the cell body



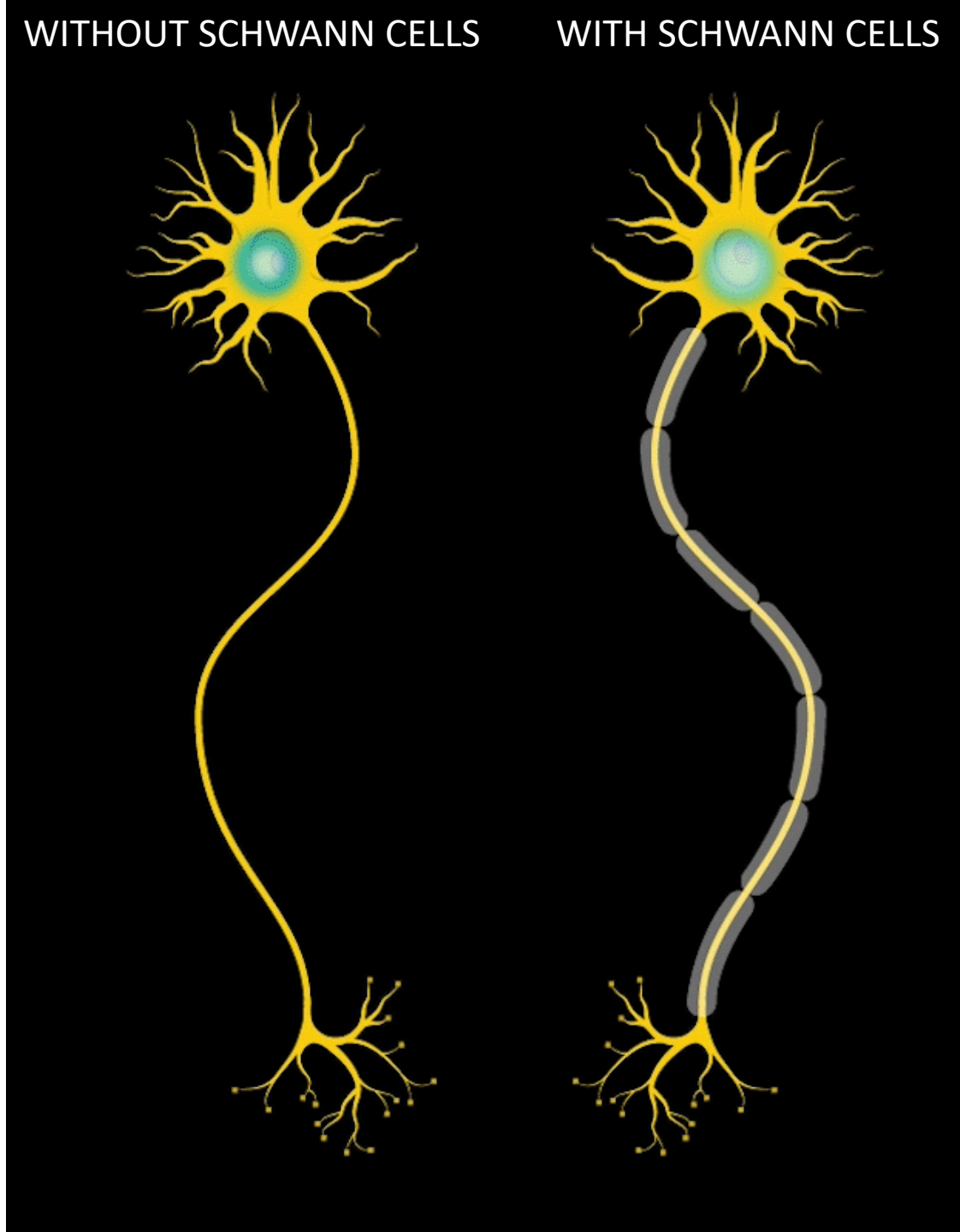
The Schwann cells produce a fatty material called Myelin which is a good insulator along the Axon of the Neuron cell.

Because of it's insulating properties, it keeps the electrical signal strong and also moving faster along the Axon, as compared to a Neuron without the Myelin, as shown in the diagram at the right.

Multiple sclerosis (MS) is a potentially disabling disease of the brain and spinal cord (central nervous system).

In MS, the immune system attacks the protective sheath (myelin) that covers nerve fibers and causes communication problems between your brain and the rest of your body.

https://www.visiblebody.com/learn/nervous/neurons



Chemical Signals: Neurons Transmit Information Through Neurotransmitters

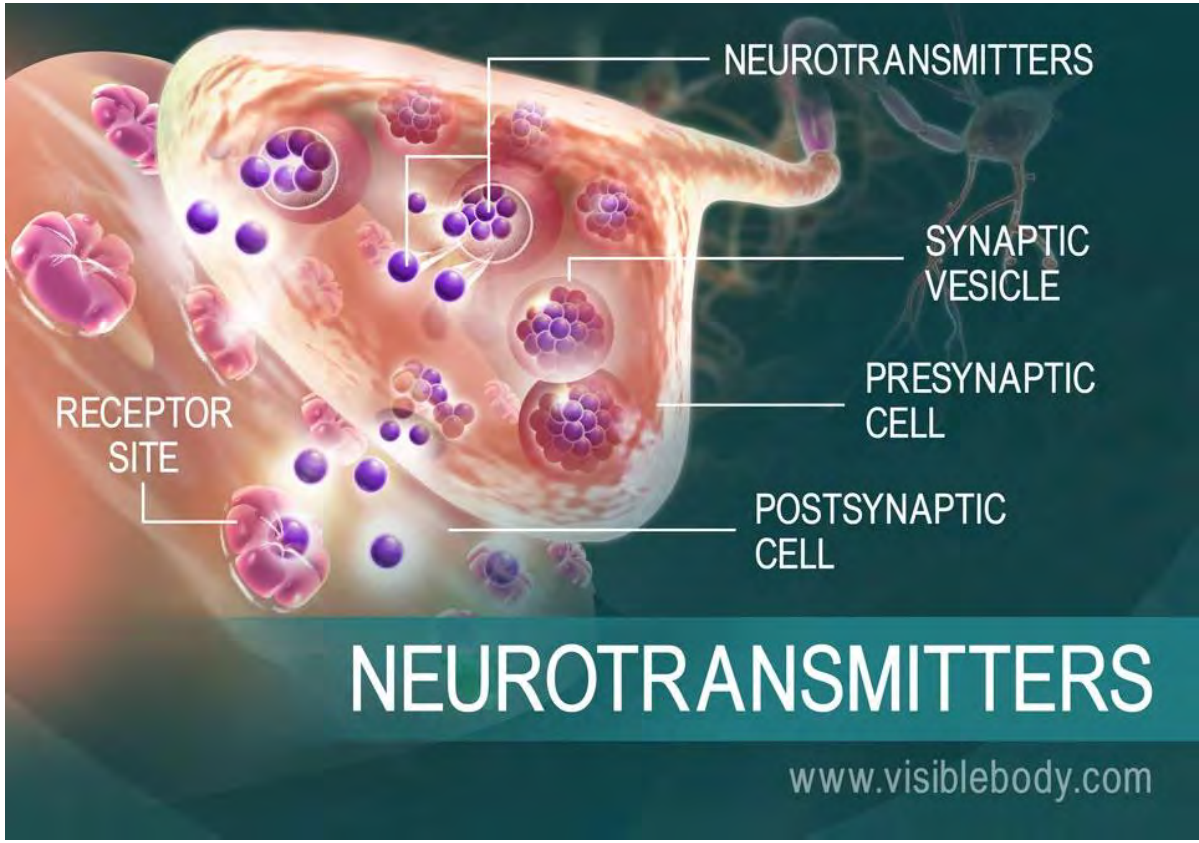
When an electrical signal reaches the axons terminal of a neuron, it stimulates the release of special chemicals called neurotransmitters.

Neurotransmitters travel across synapses to the other neurons or to target cells, stimulating or inhibiting signals and responses.

Acetylcholine, epinephrine and nor-epinephrine, and serotonin are among the most common neurotransmitters.

Some neurotransmitters are more prominent in certain parts of the nervous system because they specialize in carrying messages within the brain, or between neurons and muscular tissue or other types of tissue.

These chemicals are key to the nervous system's regulation of body movement and internal functions.



Nervous system messages travel through neurons as electrical signals.

When these signals reach the end of a neuron, they stimulate the release of neurotransmitters.

Neurotransmitters travel across synapses, spaces between neurons or between neurons and other body tissues and cells.

They can be classified as two types: excitatory or inhibitory.

Excitatory neurotransmitters stimulate electrical signals in other neurons and encourage responses from body cells.

Inhibitory transmitters discourage signals and cellular responses.

Through these chemicals, the nervous system regulates the activity of muscles, glands, and its own nerve pathways.

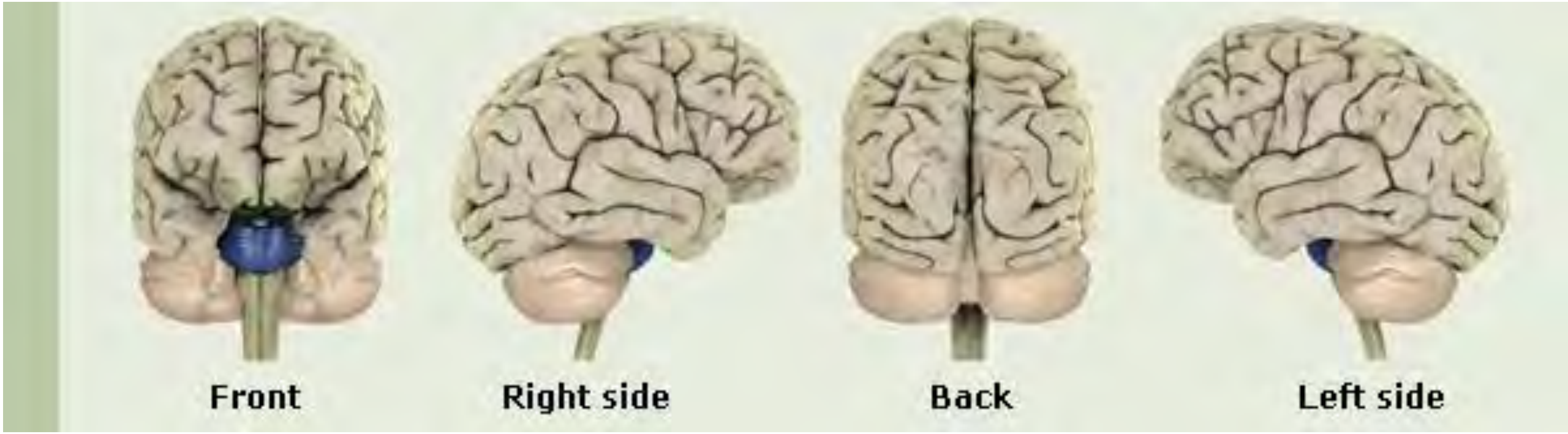
THE BRAIN

In some ways, the human brain resembles a computer.

But in addition to logical processing, it is capable of complex development, learning, self-awareness, emotion, and creativity.

Every second, millions of chemical and electrical signals pass around the brain and the body's intricate nerve network.

But nervous tissue is delicate and needs physical protection and a reliable blood supply.



These 360-degree views show each aspect of the brain clearly.

The front and back views reveal the longitudinal fissure dividing the brain into two hemispheres.

The surface of the cerebrum is folded into ridges and grooves.

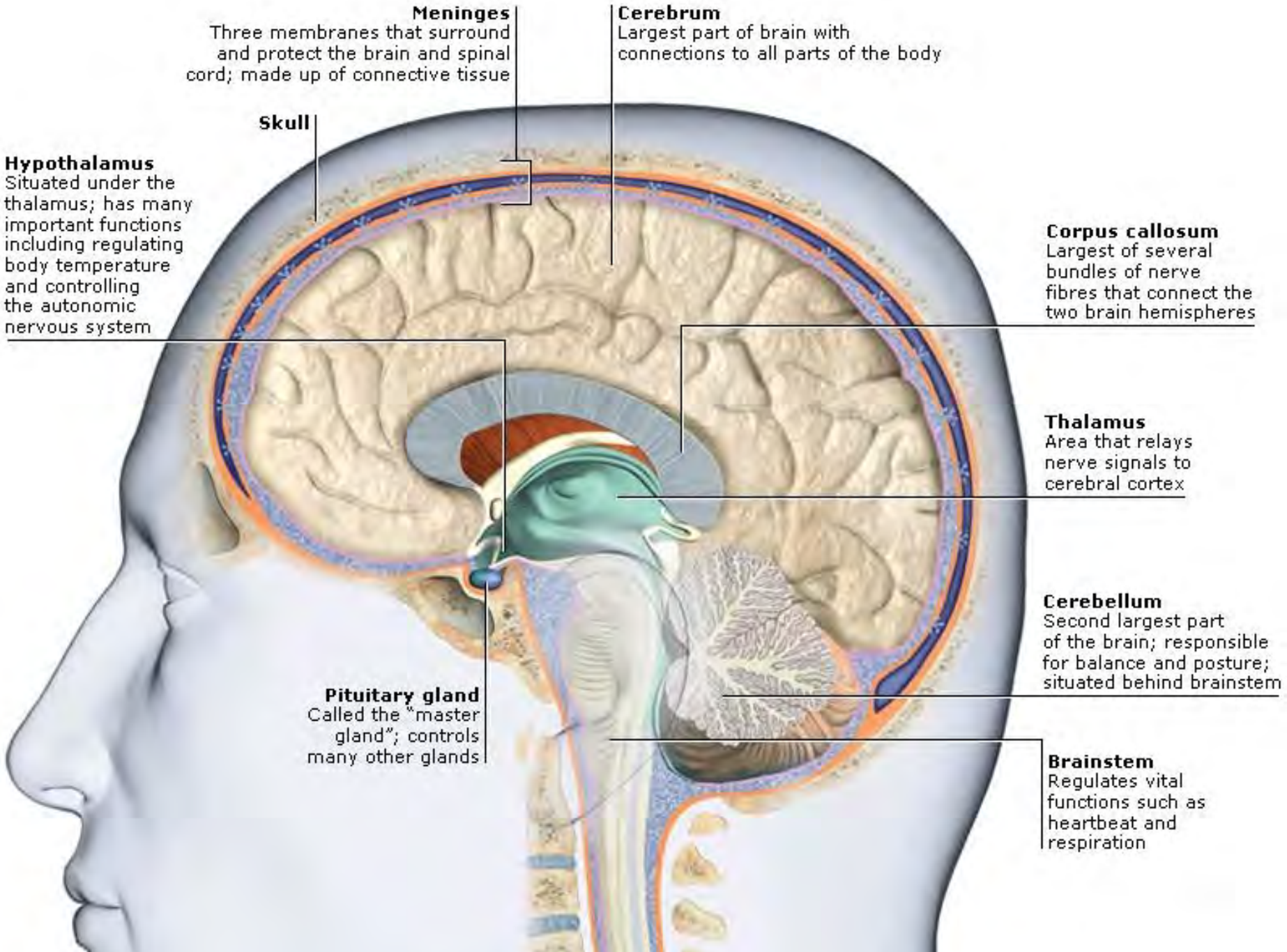
The cerebellum lies beneath the cerebrum.

The brainstem and top of the spinal cord are also visible.

The brain, in conjunction with the spinal cord, regulates both non-conscious processes and coordinates most voluntary movement.

It is the site of consciousness, allowing humans to think and learn.

It is shielded by the three protective membranes (meninges) that envelop it, and the ventricles (chambers) in the brain produce a watery medium within the skull known as cerebrospinal fluid (CSF) that absorbs and disperses excessive mechanical forces which might otherwise cause serious injury.

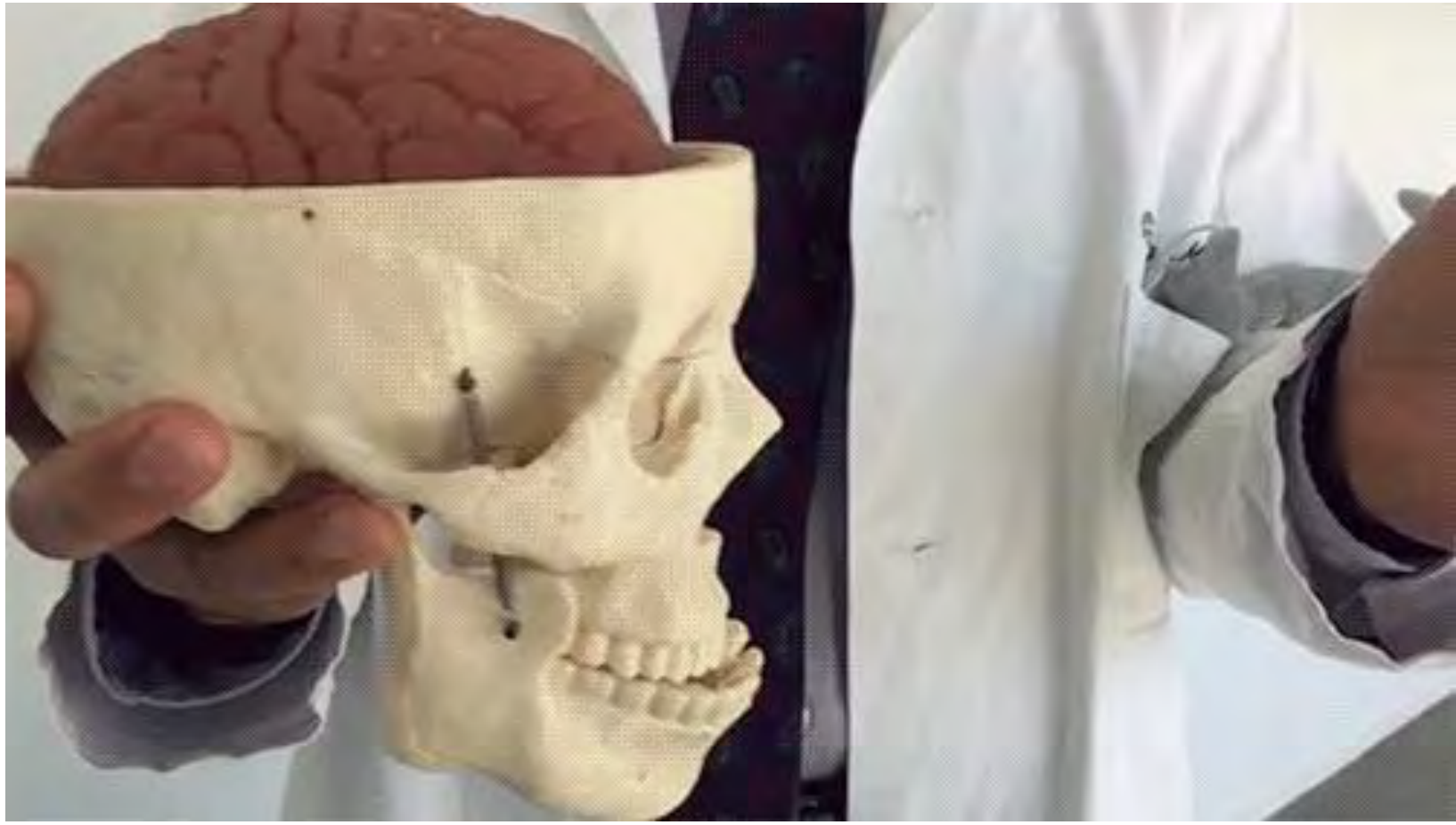

Meninges
Three membranes that surround and protect the brain and spinal cord; made up of connective tissue
Cerebrum
Largest part of brain with connections to all parts of the body
Skull
Hypothalamus
Situated under the thalamus; has many important functions including regulating body temperature and controlling the autonomic nervous system
Corpus callosum
Largest of several bundles of nerve fibres that connect the two brain hemispheres
Thalamus
Area that relays nerve signals to cerebral cortex
Cerebellum
Second largest part of the brain; responsible for balance and posture; situated behind brainstem
Pituitary gland
Called the "master gland"; controls many other glands
Brainstem
Regulates vital functions such as heartbeat and respiration

It turns out that the human brain is very fragile.

It has a consistency somewhat like jello: soft and squishy.

Without preservation and chemical hardening you couldn't pick a brain up.

The 3 layers around the brain as well as the skull and the Cerebrospinal fluid, protect the brain in case of impact from a sports injury or from a car accident.



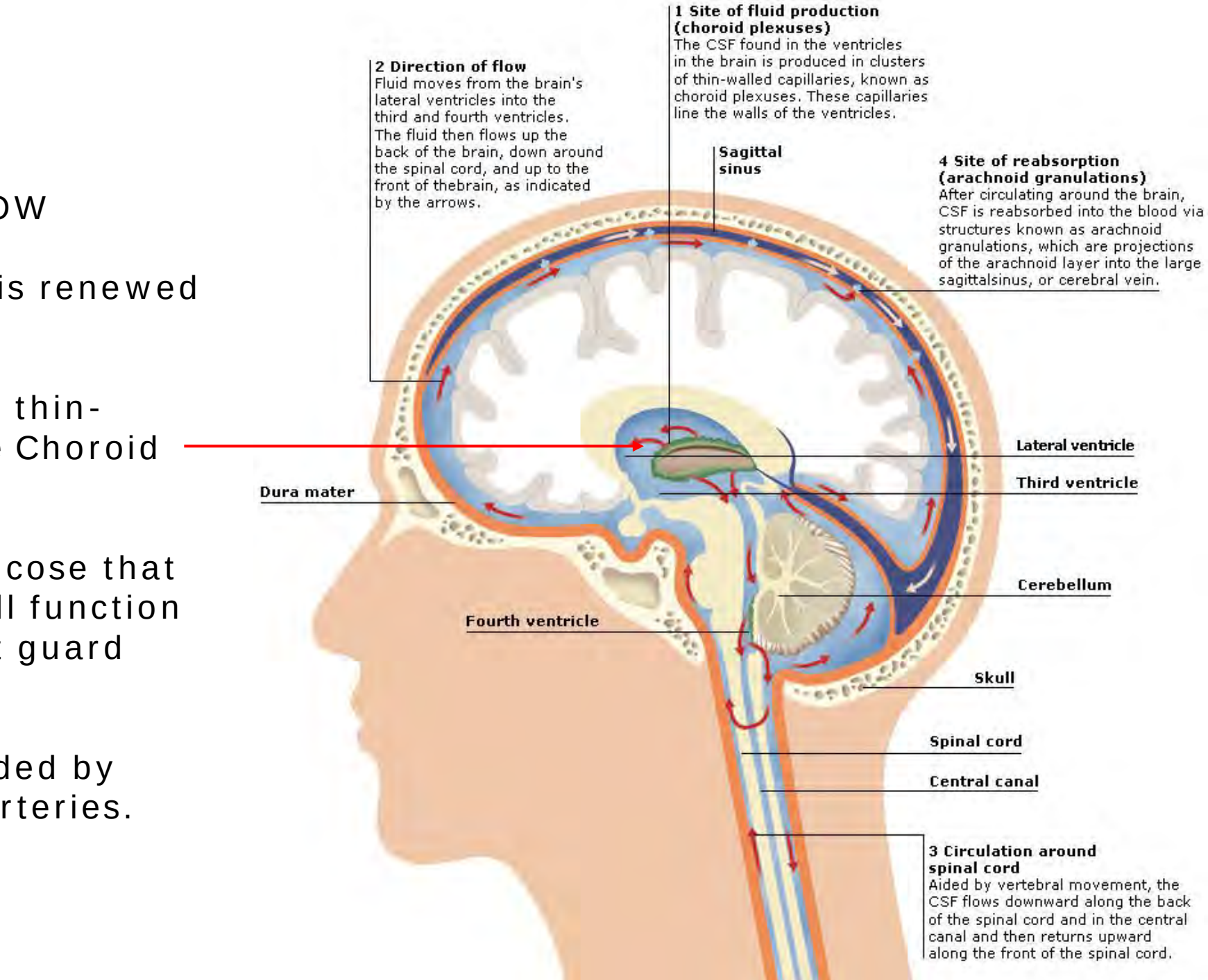
CEREBROSPINAL FLUID FLOW

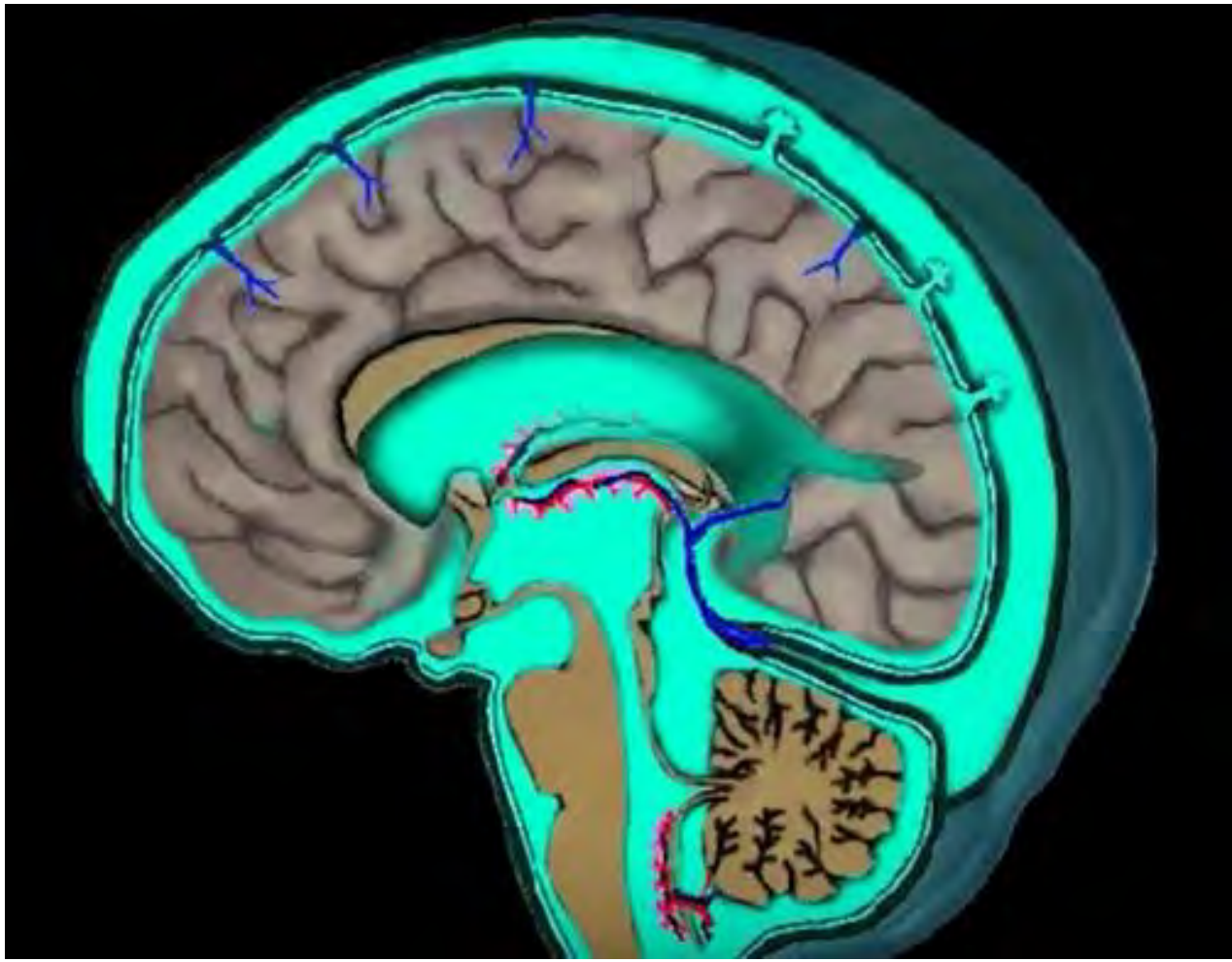
CSF is a clear liquid, which is renewed four to five times a day.

It is produced in clusters of thin-walled capillaries called the Choroid Plexuses

It contains proteins and glucose that provide energy for brain cell function as well as lymphocytes that guard against infection.

Circulation of the fluid is aided by pulsations of the cerebral arteries.

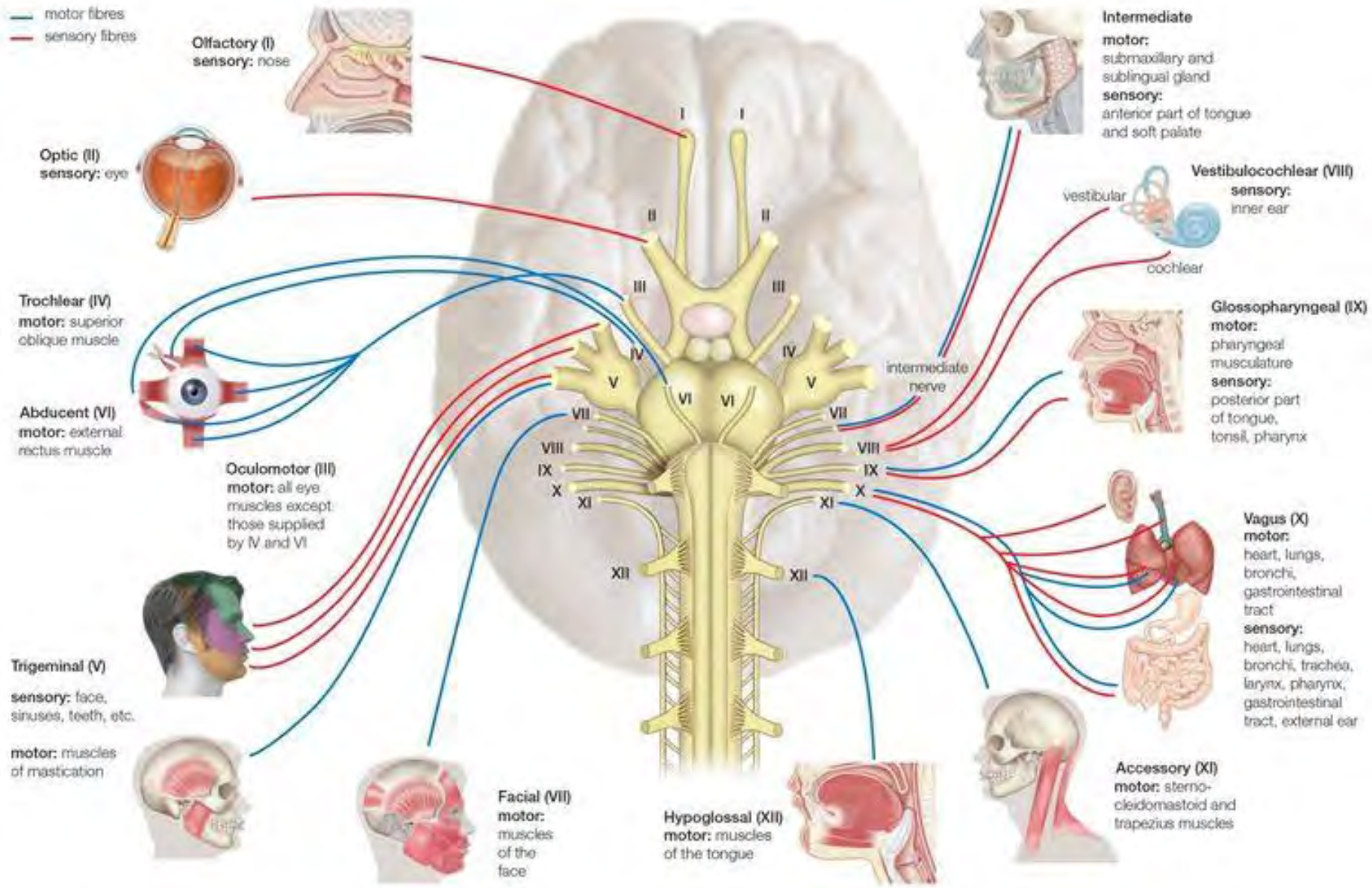

1 Site of fluid production (choroid plexuses)
The CSF found in the ventricles in the brain is produced in clusters of thin-walled capillaries, known as choroid plexuses. These capillaries line the walls of the ventricles.
2 Direction of flow
Fluid moves from the brain's lateral ventricles into the third and fourth ventricles. The fluid then flows up the back of the brain, down around the spinal cord, and up to the front of thebrain, as indicated by the arrows.
Sagittal sinus
4 Site of reabsorption (arachnoid granulations)
After circulating around the brain, CSF is reabsorbed into the blood via structures known as arachnoid granulations, which are projections of the arachnoid layer into the large sagittalsinus, or cerebral vein.
Lateral ventricle
Third ventricle
Dura mater
Cerebellum
Fourth ventricle
Skull
Spinal cord
Central canal
3 Circulation around spinal cord
Aided by vertebral movement, the CSF flows downward along the back of the spinal cord and in the central canal and then returns upward along the front of the spinal cord.



Cerebrospinal fluid being pumped between the brain and spinal cord

https://www.youtube.com/watch?v=JCf273U0ktc

Twelve pairs of cranial nerves connect the brain to eyes, ears, and other sensory organs and to head and neck muscles.



The Brain Connects Perceptions to Complex Thought, Memory, and Emotion

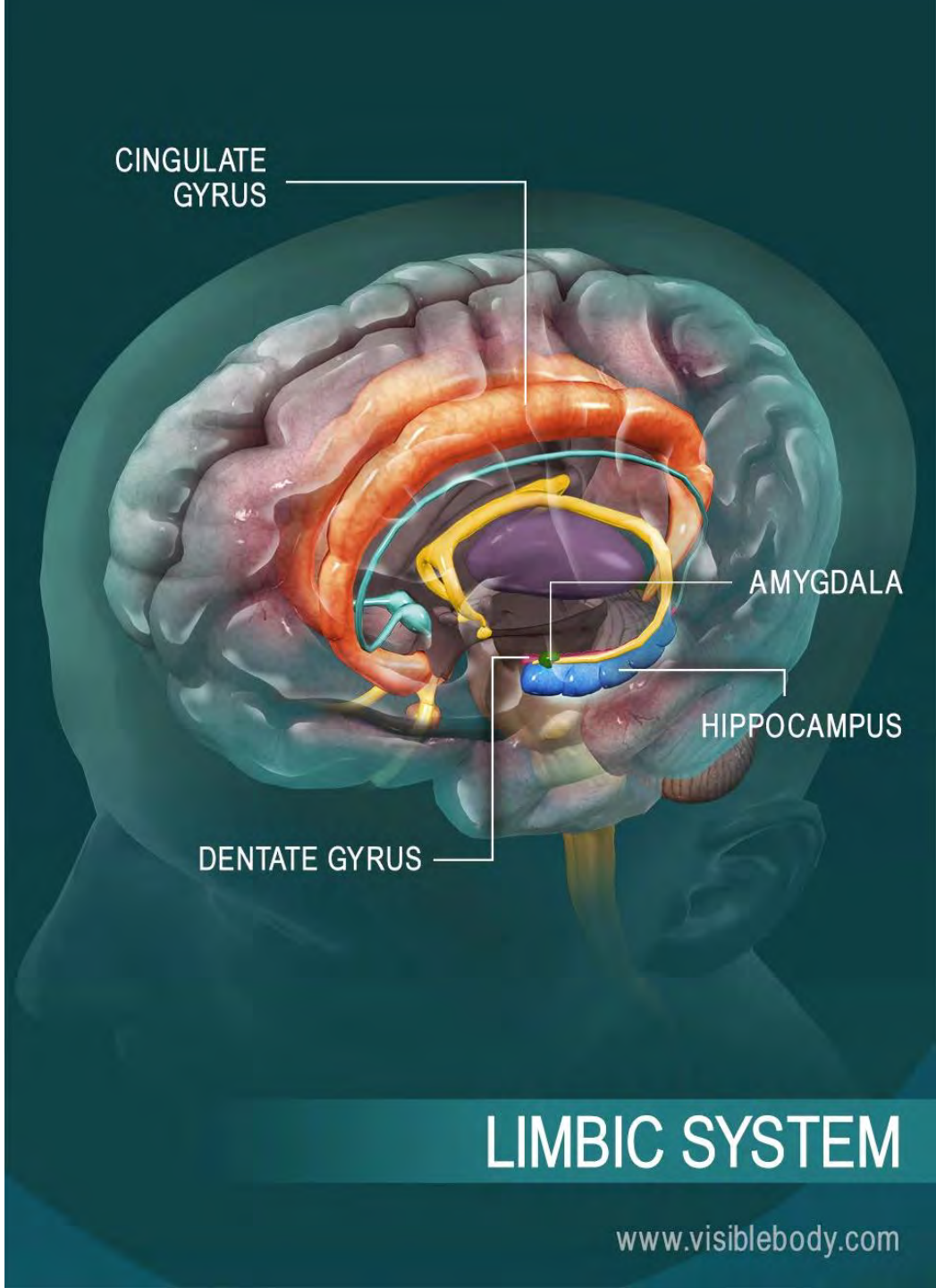
The nervous system does more than route information and process commands.

Why do certain smells immediately raise particular memories?

The answer appears to lie in the limbic system. The limbic system forms two paired rings within the brain, consisting of the hippocampus, the amygdala, the cingulate gyrus, and the dentate gyrus, along with other structures and tracts.

As with other brain segments, the limbic system is involved in multiple nervous system functions and levels of activity.

It helps to process both memory and olfaction—our sense of smell—and it manages a range of emotions. The aroma rising from a pot on the stove may send your hand reaching for a spoon. It may also call up a dinner from earlier times, and make you happy, regretful, or nostalgic.



The brain directs our body's internal functions.

It also integrates sensory impulses and information to form perceptions, thoughts, and memories.

The brain gives us self-awareness and the ability to speak and move in the world.

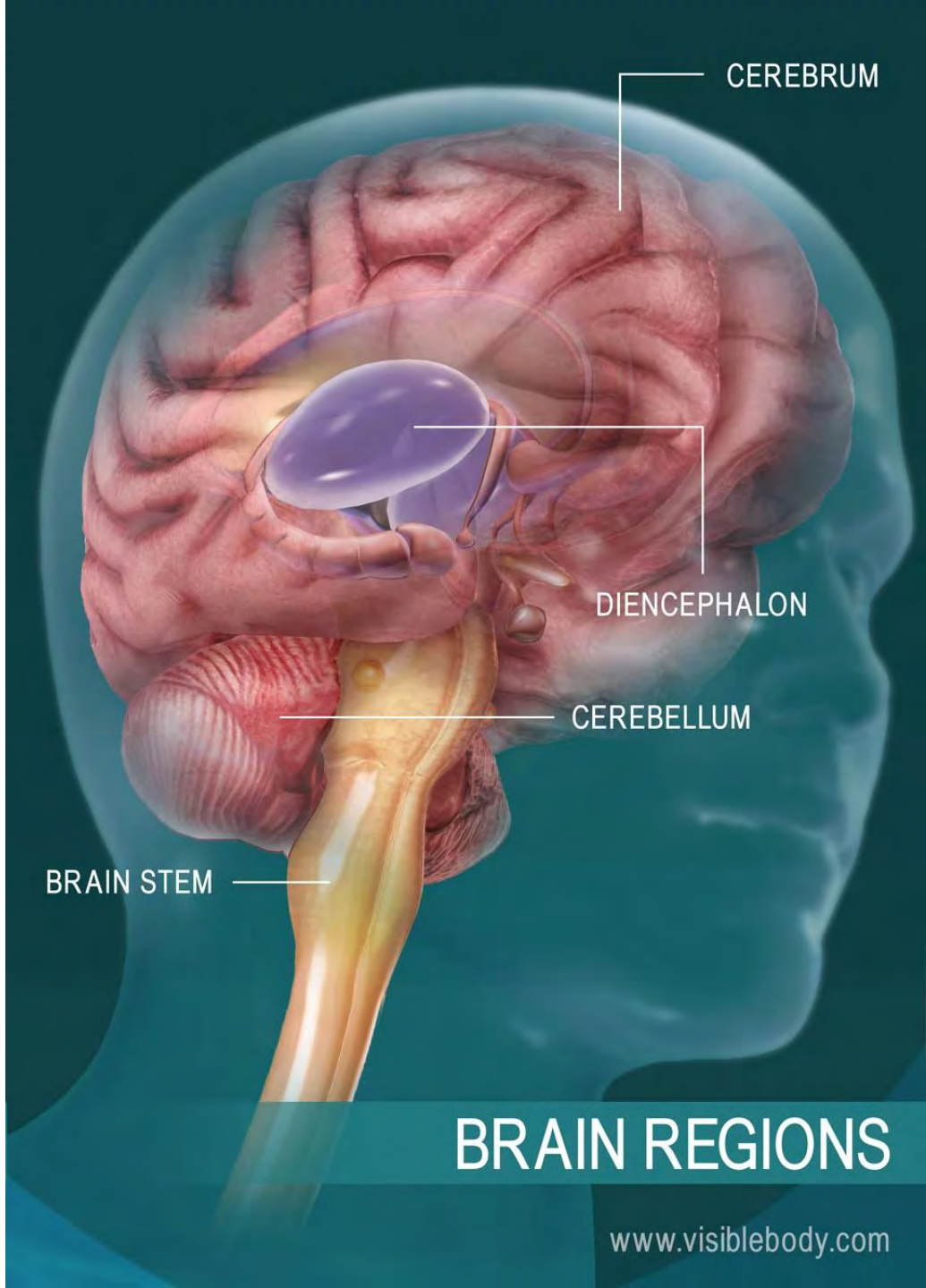
Its four major regions make this possible:

1) The cerebrum, with its cerebral cortex, gives us conscious control of our actions.

2) The diencephalon mediates sensations, manages emotions, and commands whole internal systems.

3) The cerebellum adjusts body movements, speech coordination, and balance

4) The brain stem relays signals from the spinal cord and directs basic internal functions and reflexes.

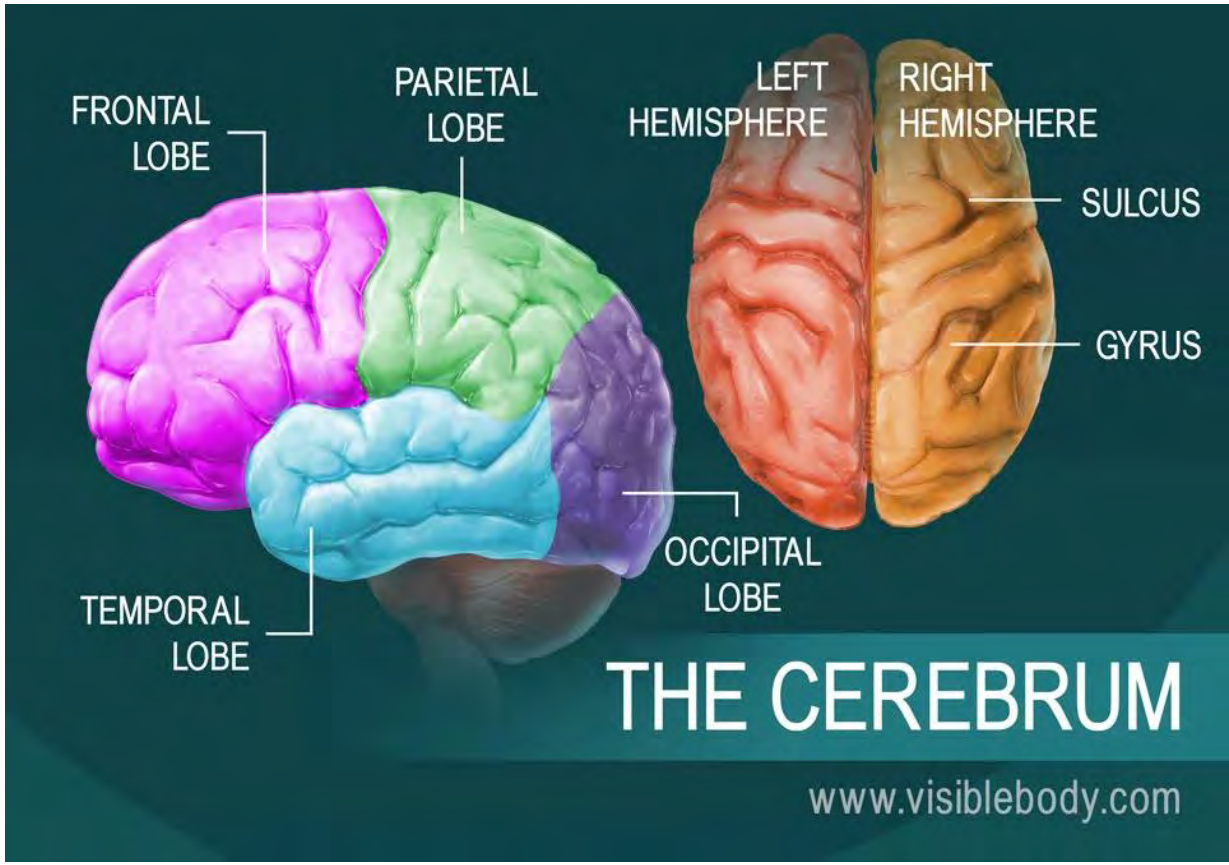


The Seat of Consciousness: High Intellectual Functions Occur in the Cerebrum

The cerebrum is the largest brain structure and part of the forebrain (or pros-encephalon).

Its prominent outer portion, the cerebral cortex, not only processes sensory and motor information but enables consciousness, our ability to consider ourselves and the outside world.

It is what most people think of when they **hear the term "grey matter."**

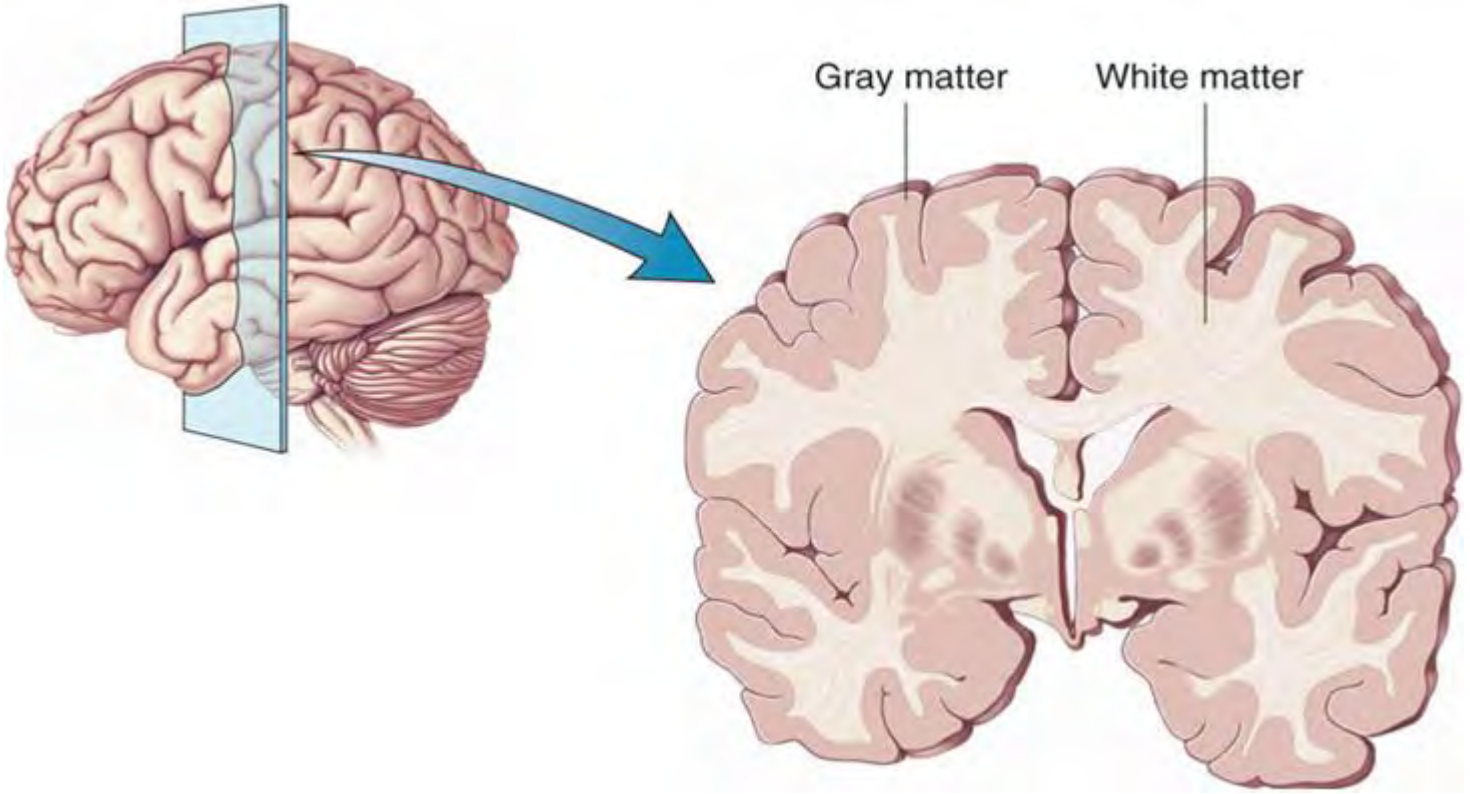


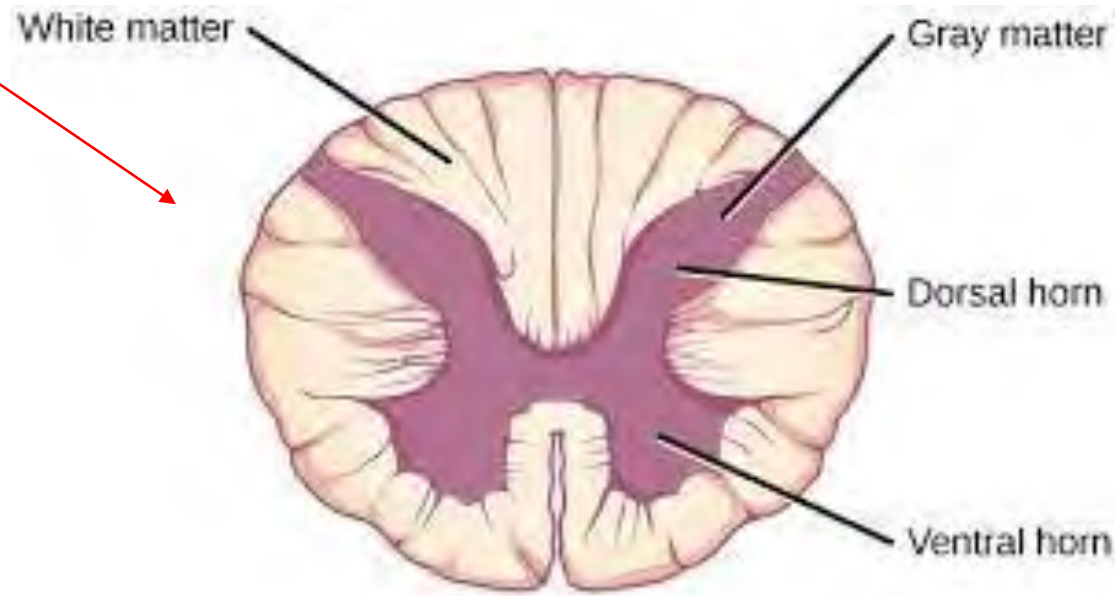
White matter is buried deep in the brain, while gray matter is mostly found on the brain's surface, or cortex. There is about 50% of each type in the brain.

The spinal cord, which transmits nerve impulses to and from the rest of the body, has the opposite arrangement: gray matter at its core with insulating white matter on the outside

The cortex tissue consists mainly of neuron cell bodies, and its folds and fissures (known as gyri and sulci) give the cerebrum its trademark rumpled surface.

Grey matter contains most of the brain's neuronal cell bodies. The grey matter includes regions of the brain involved in muscle control, and sensory perception such as seeing and hearing, memory, emotions, speech, decision making, and self-control.





The cerebral cortex has a left and a right hemisphere.

Each hemisphere can be divided into four lobes:

1) Frontal lobe

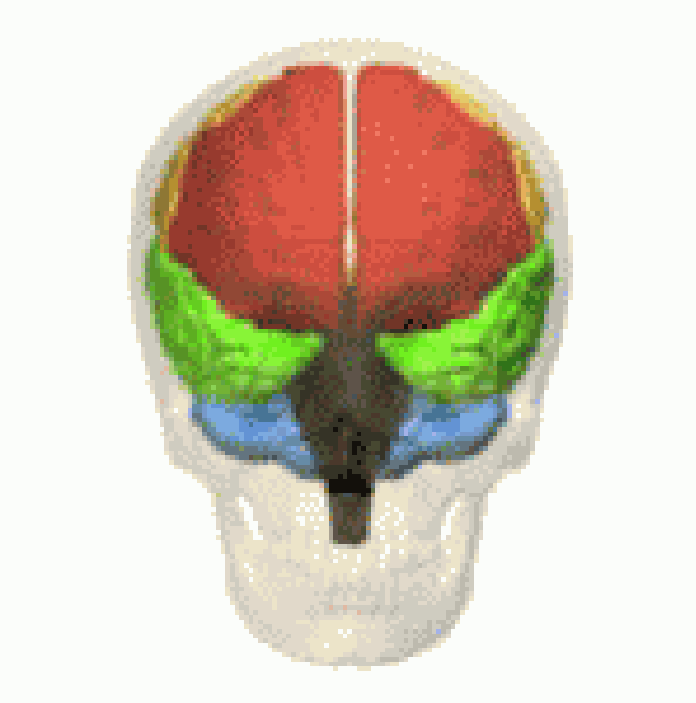
2) Temporal lobe

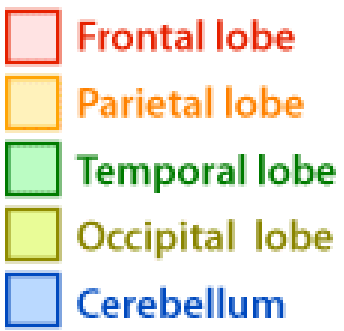
3) Occipital lobe

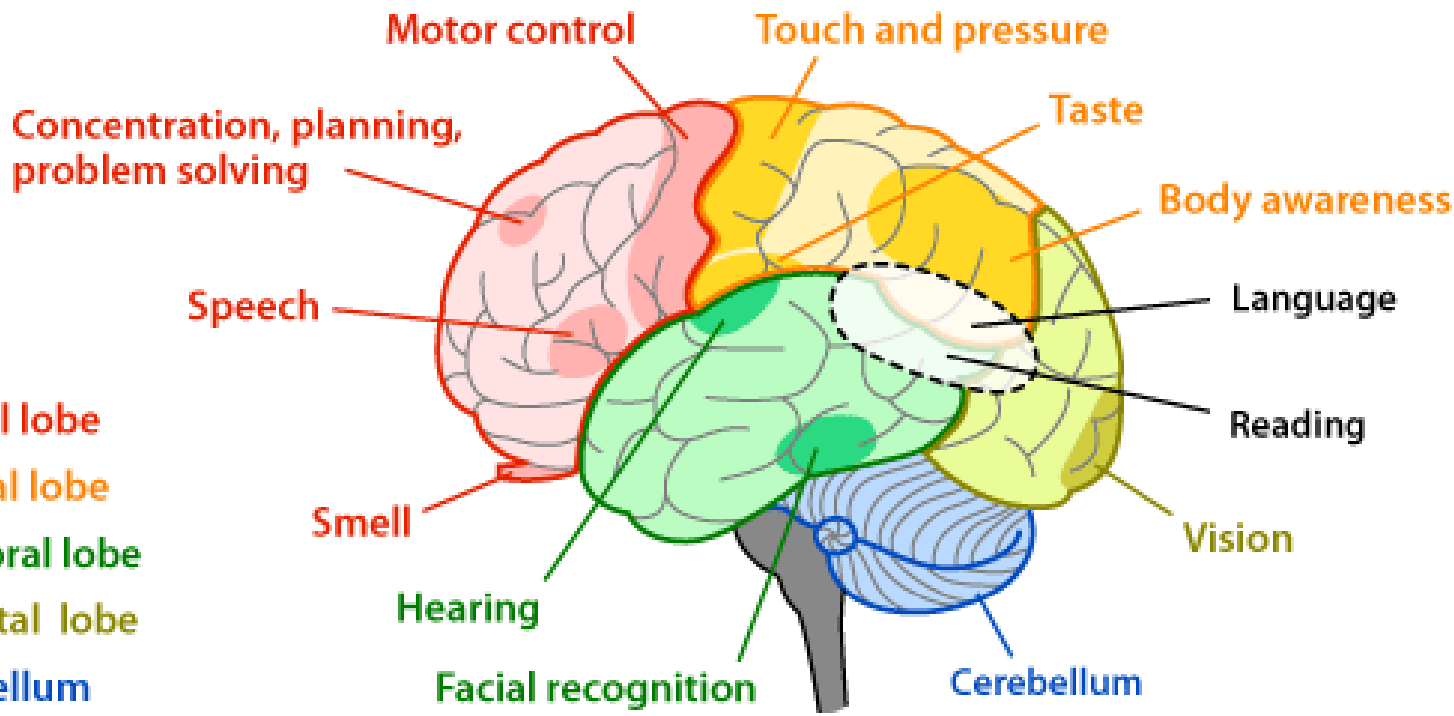
4) Parietal lobe

The lobes are functional segments.

They specialize in various areas of thought and memory, of planning and decision making, and of speech and sense perception.







THE CEREBELLUM FINE-TUNES BODY MOVEMENTS AND MAINTAINS BALANCE

The cerebellum is the second largest part of the brain.

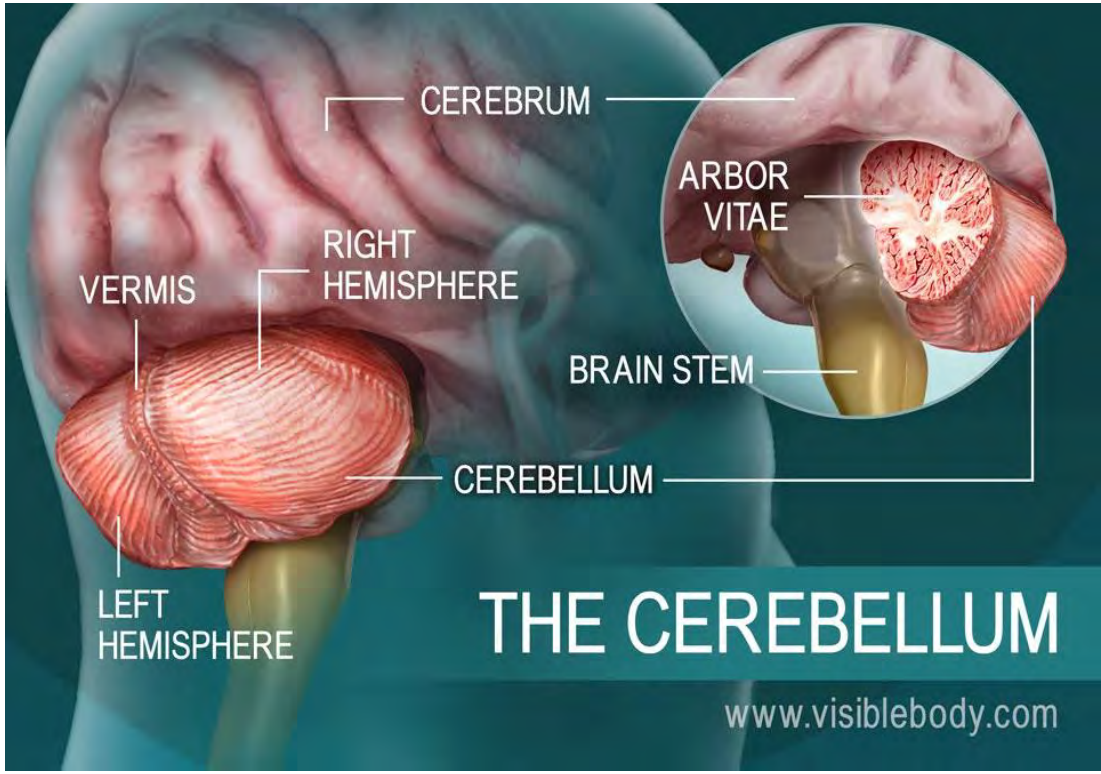
It sits below the posterior (occipital) lobes of the cerebrum and behind the brain stem, as part of the hindbrain.

Like the cerebrum, the cerebellum has left and right hemispheres. A middle region, the vermis, connects them.

Within the interior tissue rises a central white stem, called the arbor vitae because it spreads branches and sub-branches through the hemispheres.

The primary function of the cerebellum is to maintain posture and balance. When we jump to the side, reach forward, or turn suddenly, it subconsciously evaluates each movement.

The cerebellum then sends signals to the cerebrum, indicating muscle movements that will adjust our position to keep us steady.



https://www.visiblebody.com/learn/nervous/brain

The Brain Stem Relays Signals Between the Brain and Spinal Cord and Manages Basic Involuntary Functions

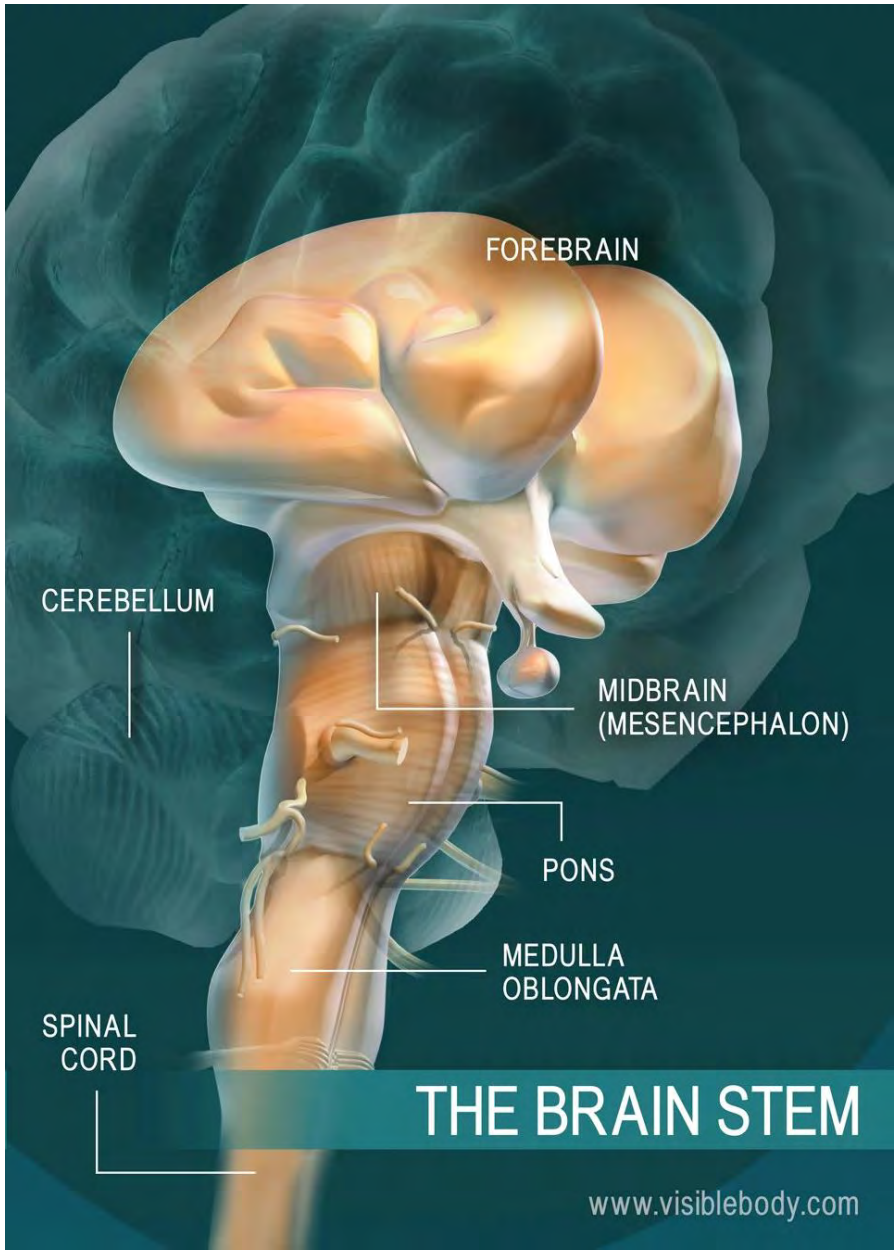
The brain stem connects the spinal cord to the higher-thinking centers of the brain.

It consists of three structures: the medulla oblongata, the pons, and the midbrain. The medulla oblongata is continuous with the spinal cord and connects to the pons above. Both the medulla and the pons are considered part of the hindbrain.

The midbrain, or mesencephalon, connects the pons to the diencephalon and forebrain.

Besides relaying sensory and motor signals, the structures of the brain stem direct involuntary functions.

- The pons helps control breathing rhythms.
- The medulla handles respiration, digestion, and circulation, and reflexes such as swallowing, coughing, and sneezing.
- The midbrain contributes to motor control, vision, and hearing, as well as vision- and hearing-related reflexes.



A Sorting Station: The Thalamus Mediates Sensory Data and Relays Signals to the Conscious Brain

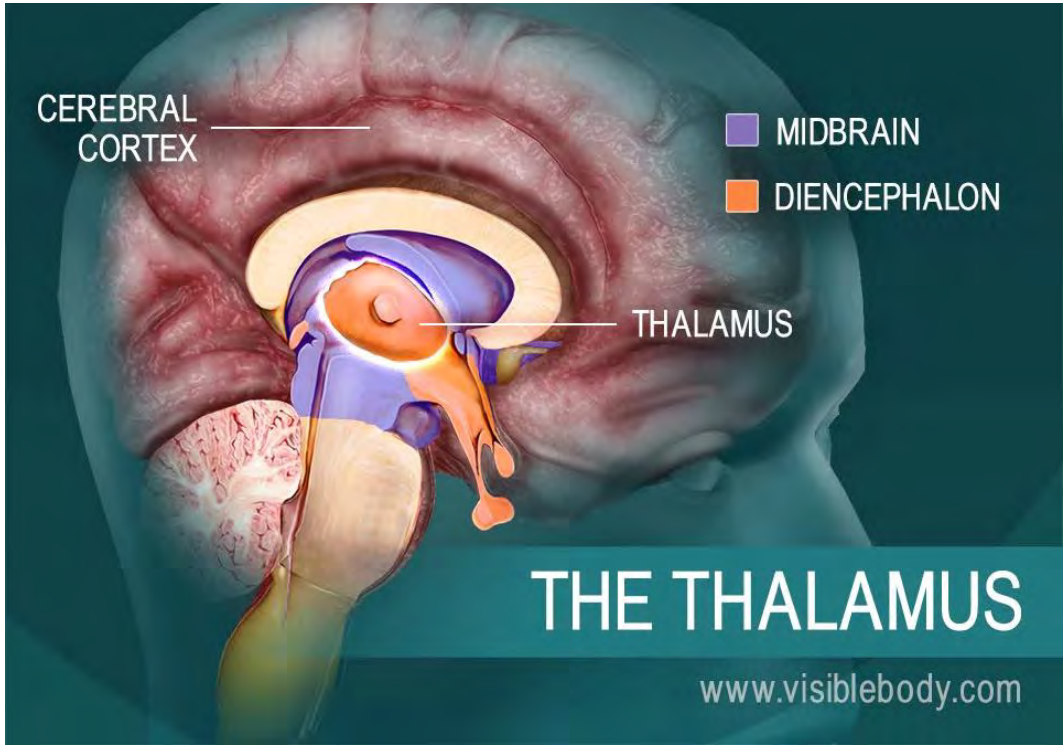
The diencephalon is a region of the forebrain, connected to both the midbrain (part of the brain stem) and the cerebrum.

The thalamus forms most of the diencephalon. It consists of two symmetrical egg-shaped masses, with neurons that radiate out through the cerebral cortex.

Sensory data floods into the thalamus from the brain stem, along with emotional, visceral, and other information from different areas of the brain.

The thalamus relays these messages to the appropriate areas of the cerebral cortex.

It determines which signals require conscious awareness, and which should be available for learning and memory.



The Hypothalamus Manages Sensory Impulses, Controls Emotions, and Regulates Internal Functions

The hypothalamus is also part of the diencephalon, a region of the forebrain that connects to the midbrain and the cerebrum.

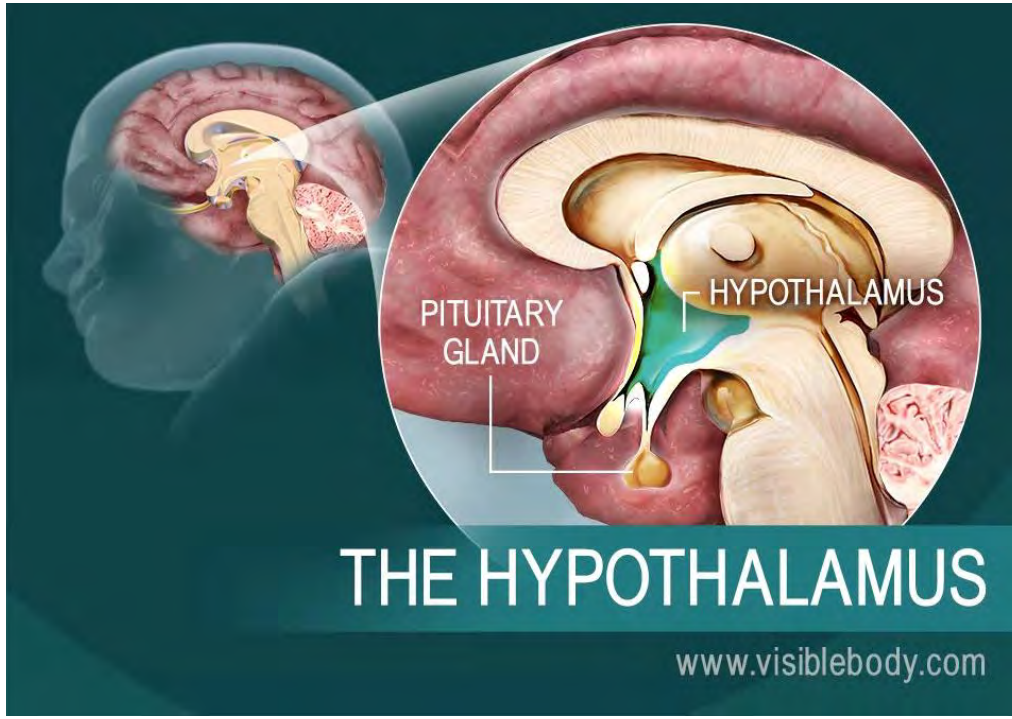
It helps to process sensory impulses of smell, taste, and vision and manages emotions such as pain and pleasure, aggression and amusement.

The hypothalamus is also our visceral control center, regulating the endocrine system and internal functions that sustain the body day to day.

It translates nervous system signals into activating or inhibiting hormones that it sends to the pituitary gland.

These hormones can activate or inhibit the release of pituitary hormones that target specific glands and tissues in the body.

Meanwhile, the hypothalamus manages the autonomic nervous system, devoted to involuntary internal functions. It signals sleep cycles and other circadian rhythms, regulates food consumption, and monitors and adjusts body chemistry and temperature.



The Triune Brain theory: Through the course of thousands of years, our brains have grown and now there are 3 different sections that formed on the one before it.

The triune brain is a model of the evolution of the vertebrate forebrain and behavior, proposed by the American physician and neuroscientist Paul D. MacLean who developed his model in the 1960s.

However, this hypothesis is no longer accepted by the majority of comparative neuroscientists.

Triune Brain Theory

Lizard Brain	Mammal Brain	Human Brain
Brain stem & cerebelum	Limbic System	Neocortex
Fight or flight	Emotions, memories, habits	Language, abstract thought, imagination, consciousness
Autopilot	Decisions	Reasons, rationalizes

(Behavioral)

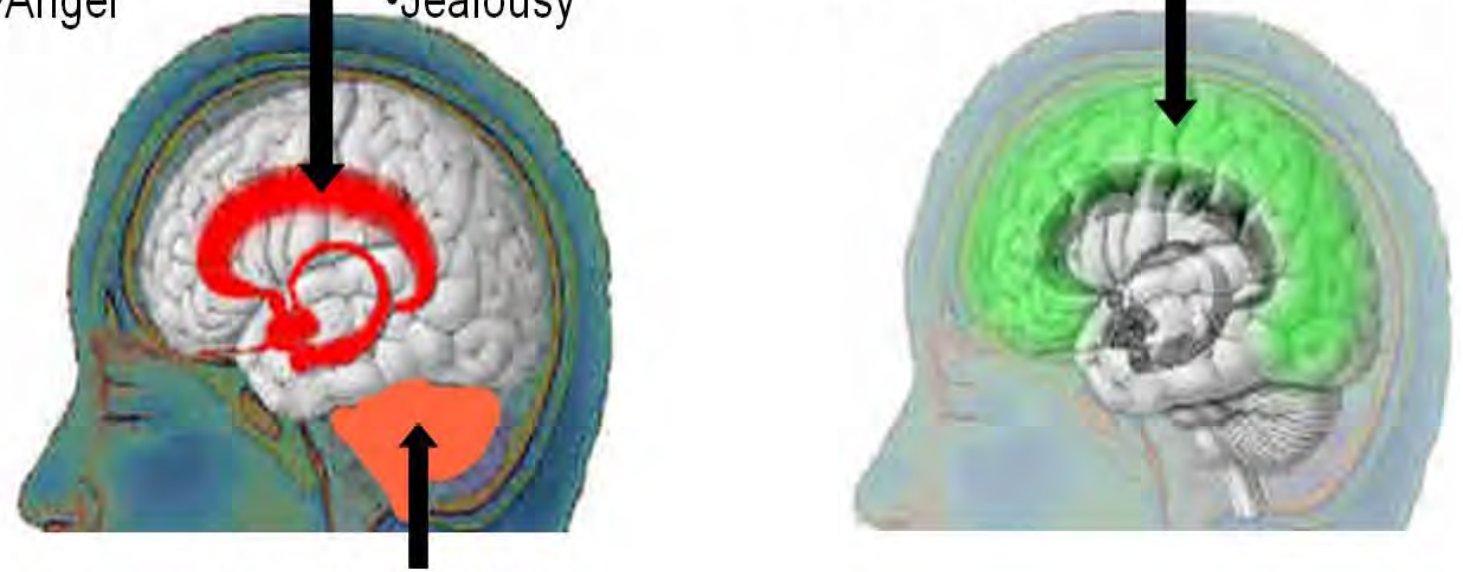
(Reflective)

Mammalian Brain

- Memory
- Sociability
- Attack
- Anger
- Maternal love
- Anxiety
- Fear/hate
- Jealousy

Neocortex

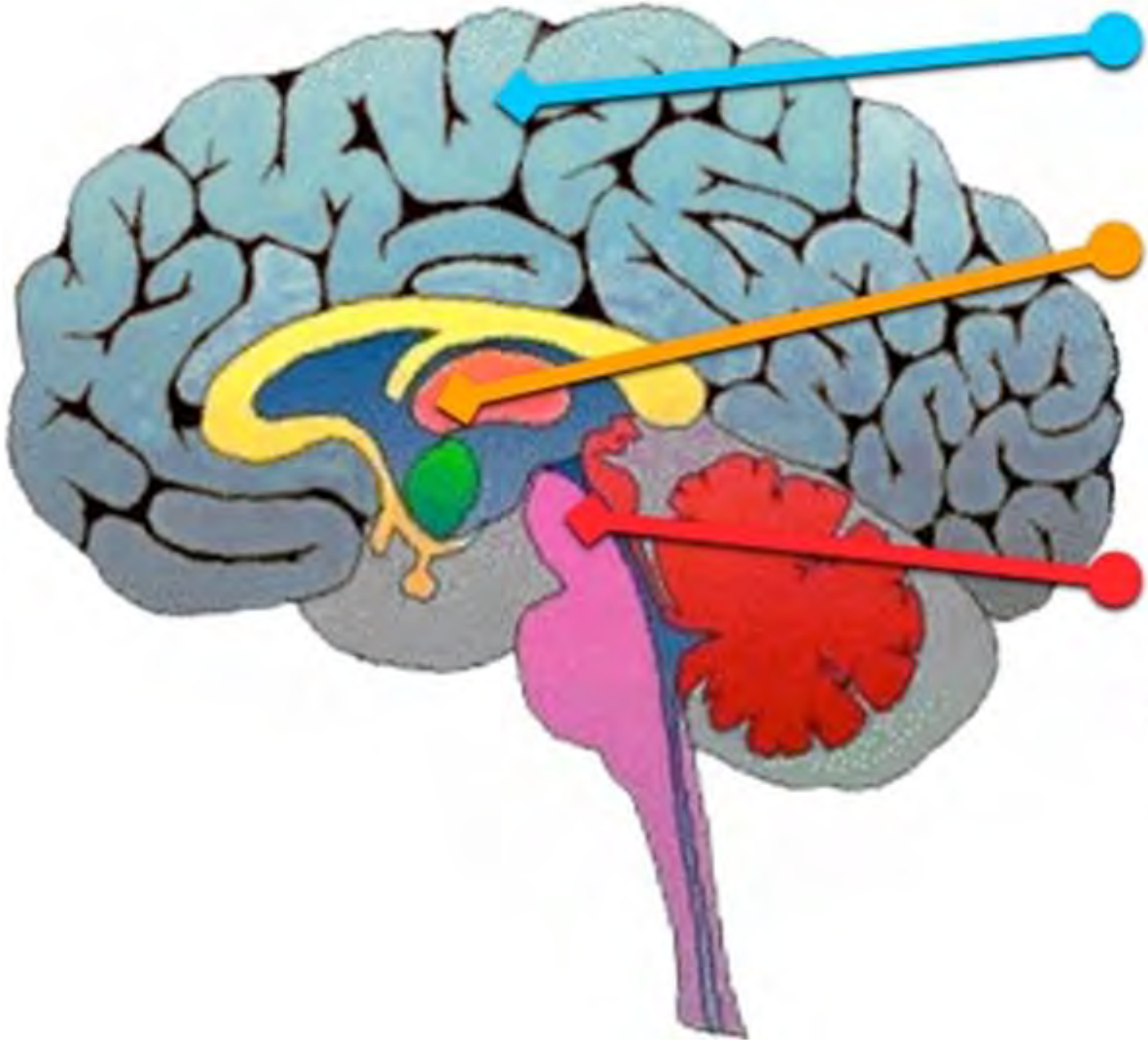
- Logic & analysis
- Rational thought
- Control of emotions
- Language
- Morality



Lizard Brain

- Breathing/ temperature
- Hunger/thirst
- Balance
- Avoidance/survival
- Territoriality
- Reproductive drive

(Visceral emotions)



Neocortex:
Rational or Thinking Brain

Limbic Brain:
Emotional or Feeling Brain

Reptilian Brain:
Instinctual or Dinosaur Brain

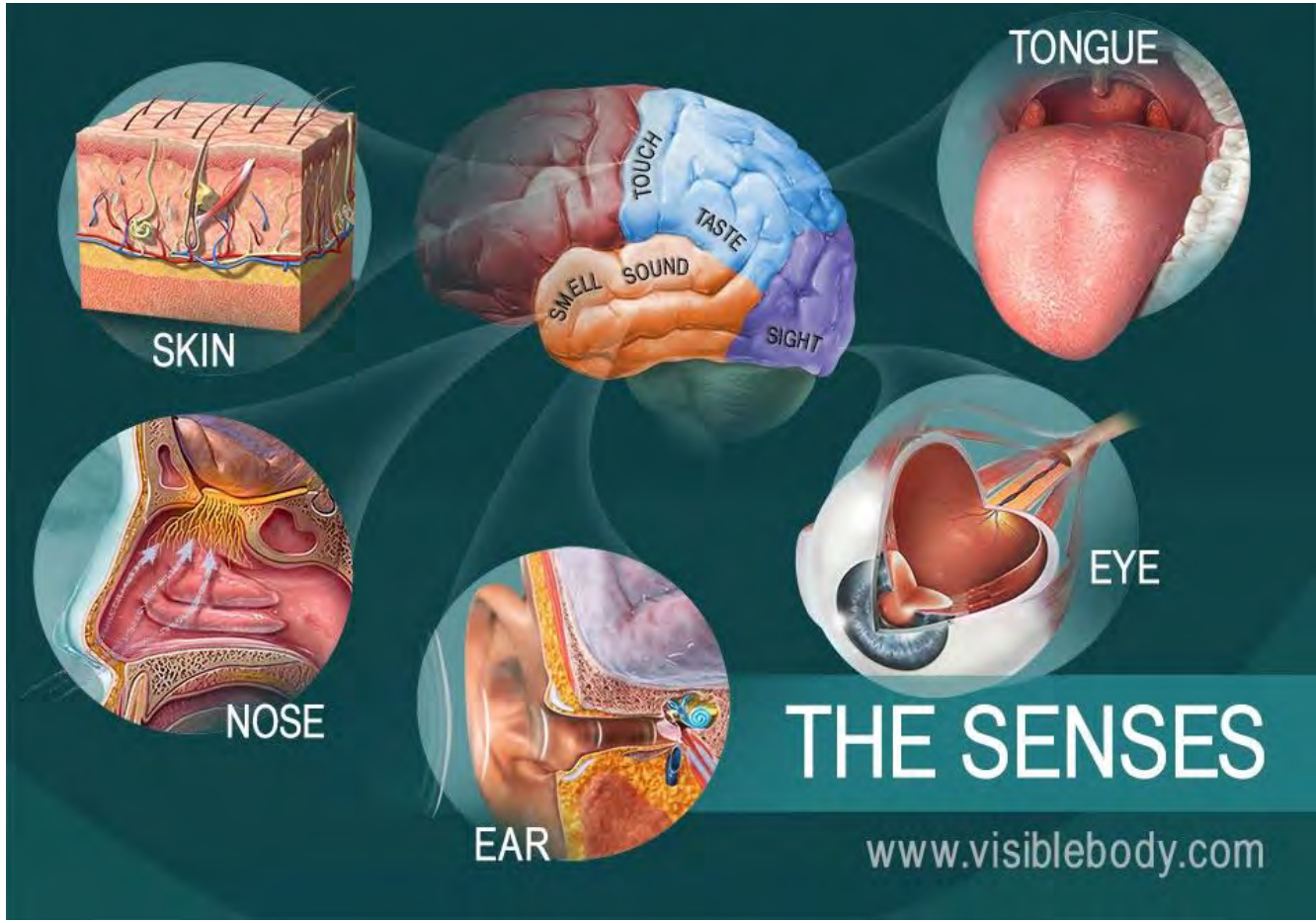
Sight, Sound, Smell, Taste, and Touch: How the Human Body Receives Sensory Information

The nervous system must receive and process information about the world outside in order to react, communicate, and keep the body healthy and safe.

Much of this information comes through the sensory organs: the eyes, ears, nose, tongue, and skin.

Specialized cells and tissues within these organs receive raw stimuli and translate them into signals the nervous system can use.

Nerves relay the signals to the brain, which interprets them as sight (vision), sound (hearing), smell (olfaction), taste (gustation), and touch (tactile perception).



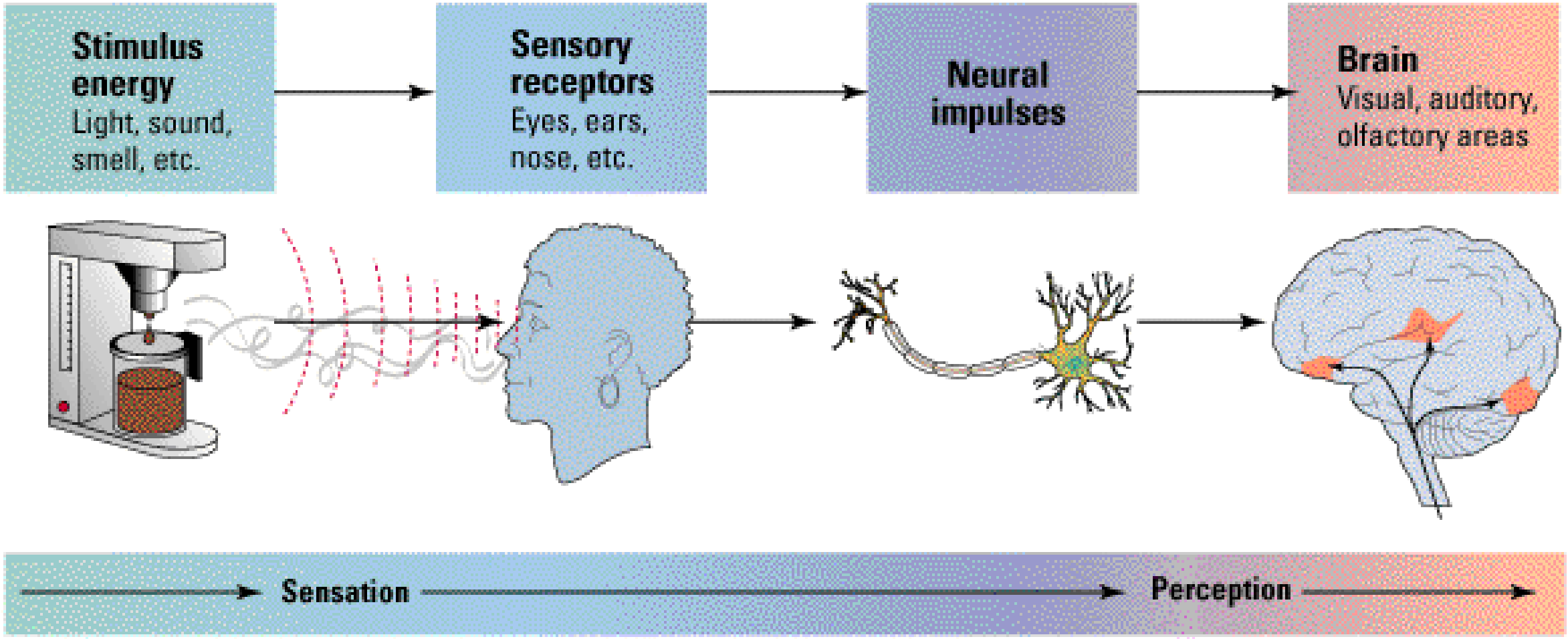
Understanding Sensation: Processing

Processing: Our five senses (vision, audition, etc.) have special receptors (example: the eye's rods & cones), which detect & transmit sensory information

Sense	Stimulus	Receptors
Vision	Light waves	Light-sensitive rods and cones in eye's retina
Audition (hearing)	Sound waves	Pressure-sensitive hair cells in ear's cochlea
Olfaction (smell)	Molecules dissolved on nose's mucous membranes	Neurons in the nose's olfactory epithelium
Gustation (taste)	Molecules dissolved on tongue	Taste buds on tongue's surface
Body Senses	Variety of stimuli	Variety of receptors

©

Sensation & Perception Processes



Absolute Thresholds - the minimum amount of stimulus energy that humans can detect 50% of the time.

- Taste: 1 gram (.0356 ounce) of table salt in 500 liters (529 quarts) of water
- Smell: 1 drop of perfume diffused throughout a three-room apartment
- Touch: the wing of a bee falling on your cheek from a height of 4 tenths of an inch (.4 inch)
- Hearing: the tick of a watch from 6 meters (20 feet) away, in very quiet conditions
- Vision: a candle flame seen from 50km (30 miles) on a clear, dark night

The Eyes Translate Light into Image Signals for the Brain to Process

The white part of the eye is the sclera. It protects interior structures and surrounds a circular portal formed by the cornea, iris, and pupil.

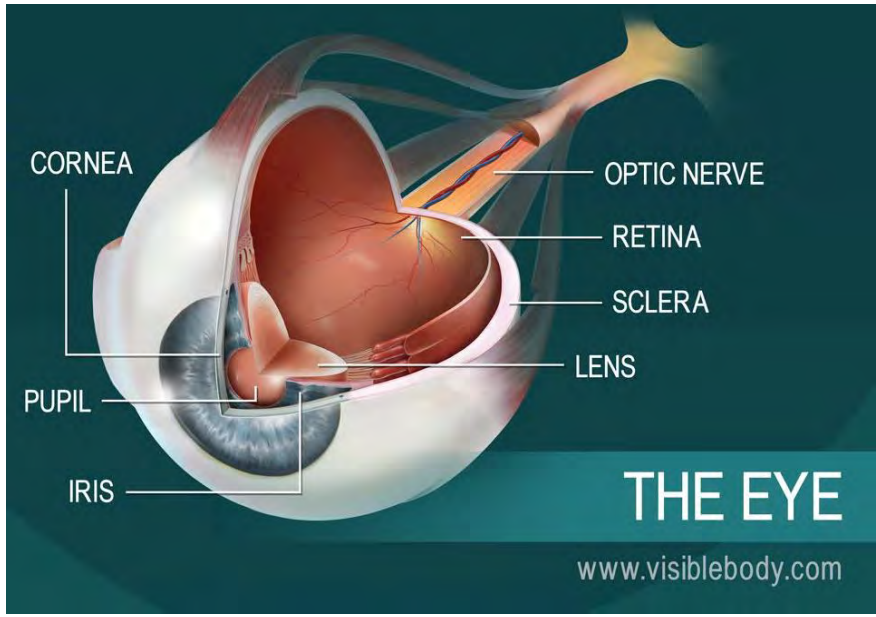
The cornea is transparent to allow light to enter the eye and curved to direct it through the pupil behind it.

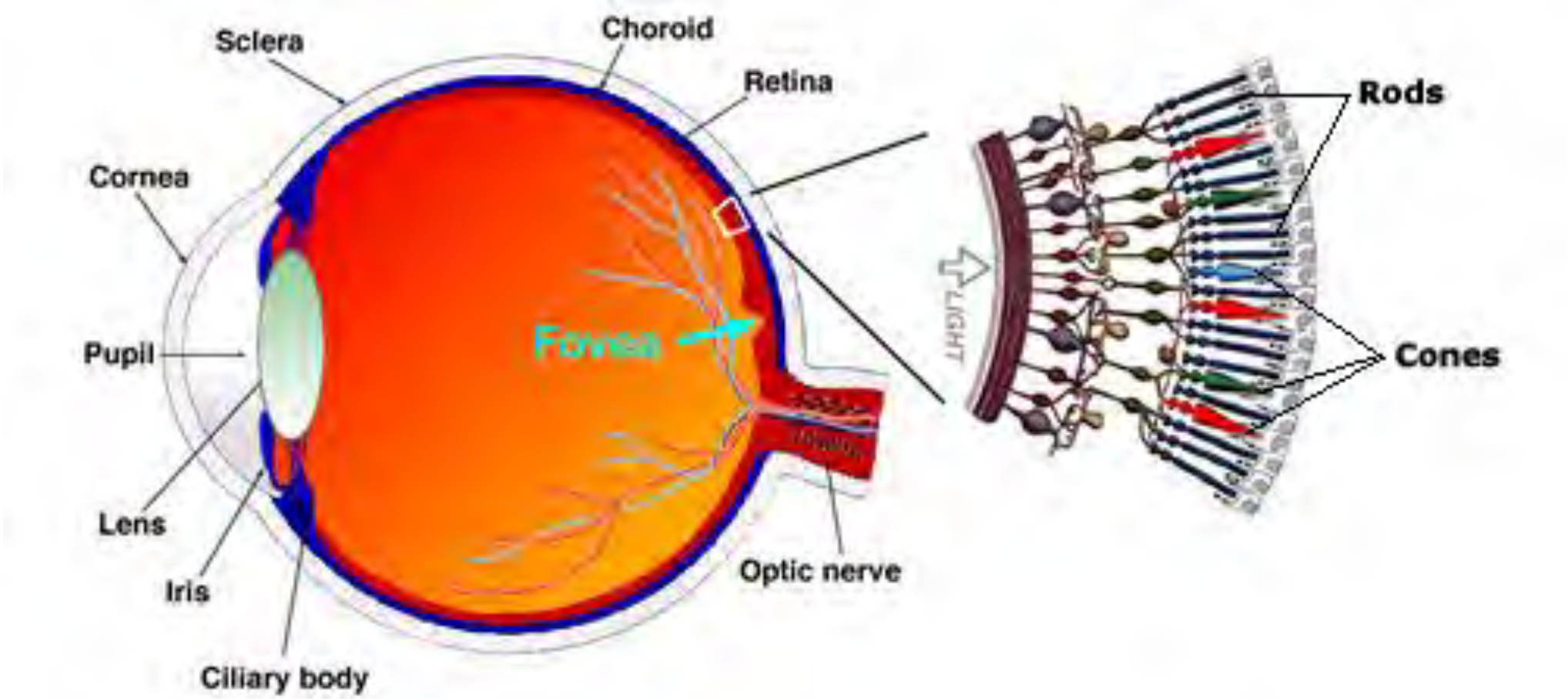
The pupil is actually an opening in the colored disk of the iris. The iris dilates or constricts, adjusting how much light passes through the pupil and onto the lens.

The curved lens then focuses the image onto the retina, the **eye's interior layer. The retina is a delicate membrane of** nervous tissue containing photoreceptor cells.

These cells, the rods and cones, translate light into nervous signals.

The optic nerve carries the signals from the eye to the brain, which interprets them to form visual images.

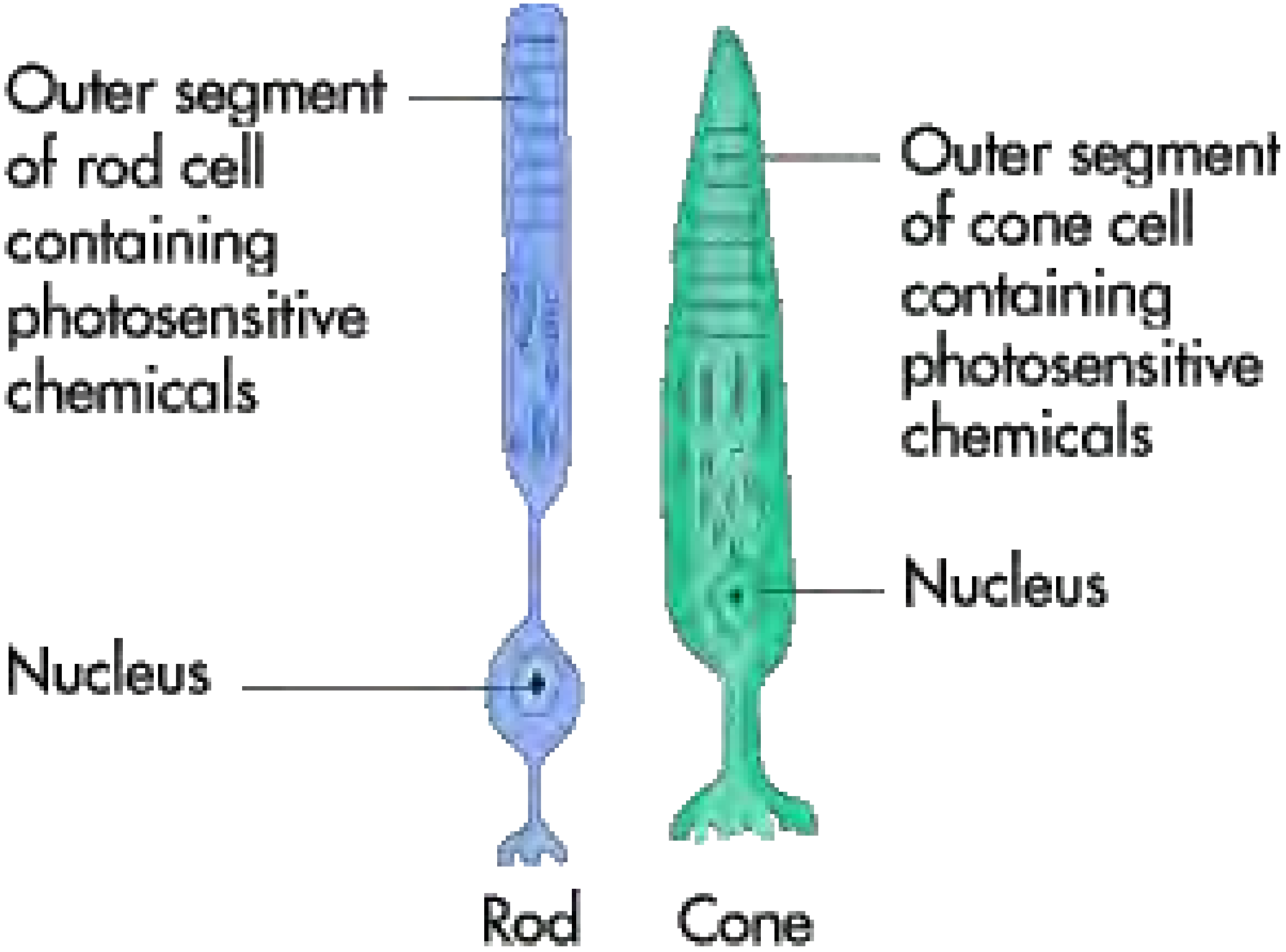




The fovea and foveal pit are where visual acuity and color vision are the best because of the high concentration of cones there. The fovea is located directly opposite the eye's lens system for optimum focusing.

Cells of the retina perform the initial processing of images and transmit the resulting neural impulses to the brain via the optic nerve. The retina of each eye has approximately 126 million receptor cells: 120 million rods and 6 million cones.

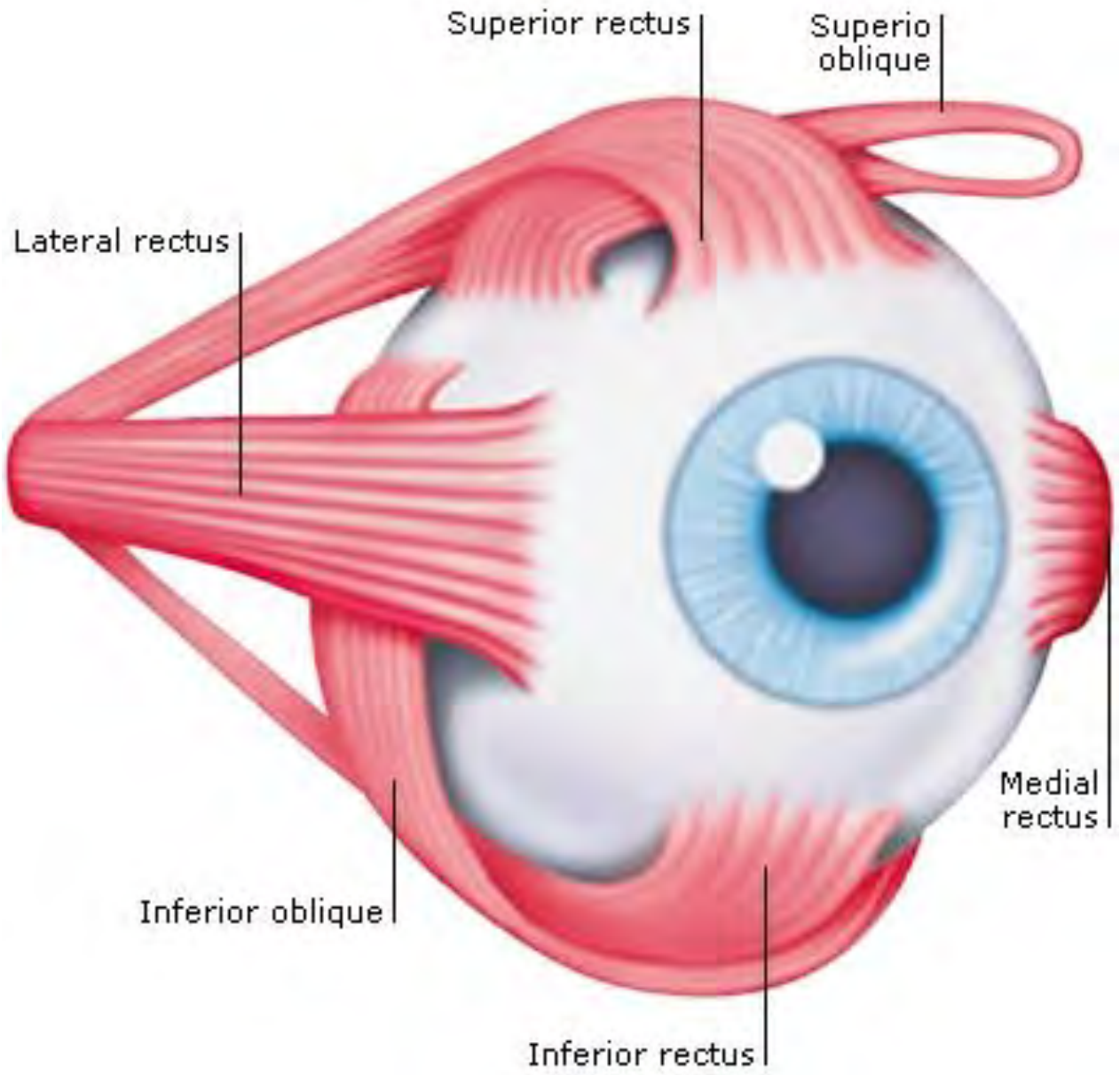
Rods are responsible for our night vision and cones for our day and color vision.


Outer segment of rod cell containing photosensitive chemicals
Nucleus
Rod
Outer segment of cone cell containing photosensitive chemicals
Nucleus
Cone

EYE MUSCLES OF THE RIGHT EYE

The six extrinsic eye muscles are 1- 1/5–1-2/5 inches long.

They contract or relax in close coordination to move the eyeball within its socket.



MEDICAL ISSUES OF THE EYES

Refractive errors

The 4 common refractive errors are:

Myopia, or nearsightedness - clear vision close up but blurry in the distance

Hyperopia, or farsightedness - clear vision in the distance but blurry close up

Presbyopia - inability to focus close up as a result of aging

Astigmatism - focus problems caused by the cornea

Cataracts - clouded lenses

Optic nerve disorders, including glaucoma

Retinal disorders - problems with the nerve layer at the back of the eye

Macular degeneration - a disease that destroys detailed, central vision

Diabetic eye problems

Cataracts

- A cataract is opacity or clouding of the lens that may develop as a result of aging, trauma, hereditary factors, birth defects, or diabetes

- They are a normal part of aging

- Approximately 50% of Americans between 65 and 74 and 70% over age 75 have cataracts

  The greater the progression of the cataract, the greater the visual impairment from the effects of glare, loss of contrast, and decreased visual acuity

- Normally, cataracts are successfully treated with surgery

No cataract

cataract

Normal vision

Vision through a cataract

Glaucoma

- If left untreated, results in the destruction of the peripheral retina

- There are 3 types of glaucoma:

  - Chronic open-angle glaucoma: elevated pressure over time eventually affects the optic nerve and visual field

  - Acute (closed-angle) glaucoma: rapid increase or spiking of the intraocular pressure that may be accompanied by intense pain and even nausea or vomiting

  - Low-tension glaucoma: may be caused by a decrease in blood flow to the optic nerve

- Over a period of time, especially if left untreated, irreversible optic nerve and visual field damage will occur, impairing night vision, visual acuity, mobility, and reading skills

Retinitis Pigmentosa

- A progressive eye disease that affects the pigmentary layer of the retina, and most commonly affects the periphery or mid-periphery of the retina

- Most common cause of inherited blindness

- In addition, 30% of people with RP report some degree of hearing loss

  - ❖ Night vision and peripheral vision go hand in hand - the more advanced the RP, the greater loss of peripheral vision and the more difficult to travel

  - ❖ Reading becomes more and more difficult as the visual field becomes small

  - ❖ Glare or light sensitivity is frequently associated with RP

Diabetic Retinopathy

- Diabetes accounts for about 5,000 new cases of blindness each year and people with diabetes have a 25 times greater risk for blindness than the general population

- Approximately 40% of people with diabetes have diabetic retinopathy

- Fluctuating or severely decreased visual acuity

- Problems due to glare, reduced contrast sensitivity, and various types of visual field problems

Macular Degeneration

- Macular degeneration is caused by degenerative changes to the macular area of the retina that results in a loss of central vision.

- Visually manifested as distortions, a decrease in the visual acuity, a decrease in color recognition, a loss of contrast, or an absolute or relative area of no vision (scotoma)

- Reading may become increasingly difficult and driving may have to be discontinued

This time-lapse animation illustrates the central vision loss of a patient with macular degeneration.

COLOR BLINDNESS - It can be of many types ranging from:

1) Very slight difficulties in discriminating different colors

2) Difficulties in seeing red or green or both

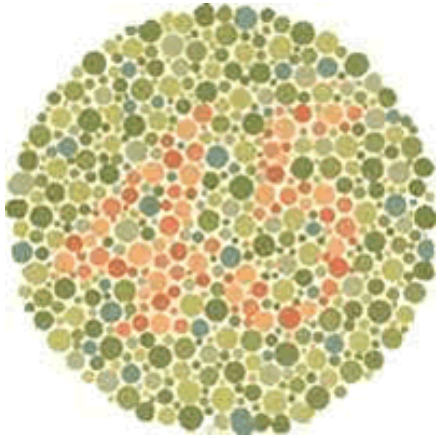
3) Inability to see blue

4) The total absence of color vision.

Color vision also changes with age. As the lens of the eye yellows, it absorbs short wavelengths and reduces our ability to see blue.

Also, the amount of light entering the eye is reduced, so that all colors appear dimmer.

Color Vision Test Normal color vision = "5" Red/Green color deficiency = "2"

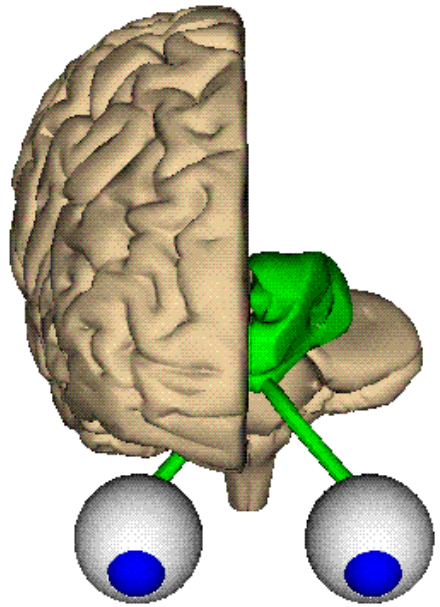


Color Vision Test Normal color vision = "45" Red/Green color deficiency = "spots"

https://www.youtube.com/watch?v=FKSOe5NK_qQ

The occipital lobe is one of the four major lobes of the cerebral cortex in the brain of mammals.

It is the visual processing center of the mammalian brain containing most of the anatomical region of the visual cortex.



HOW OUR VISION WORKS

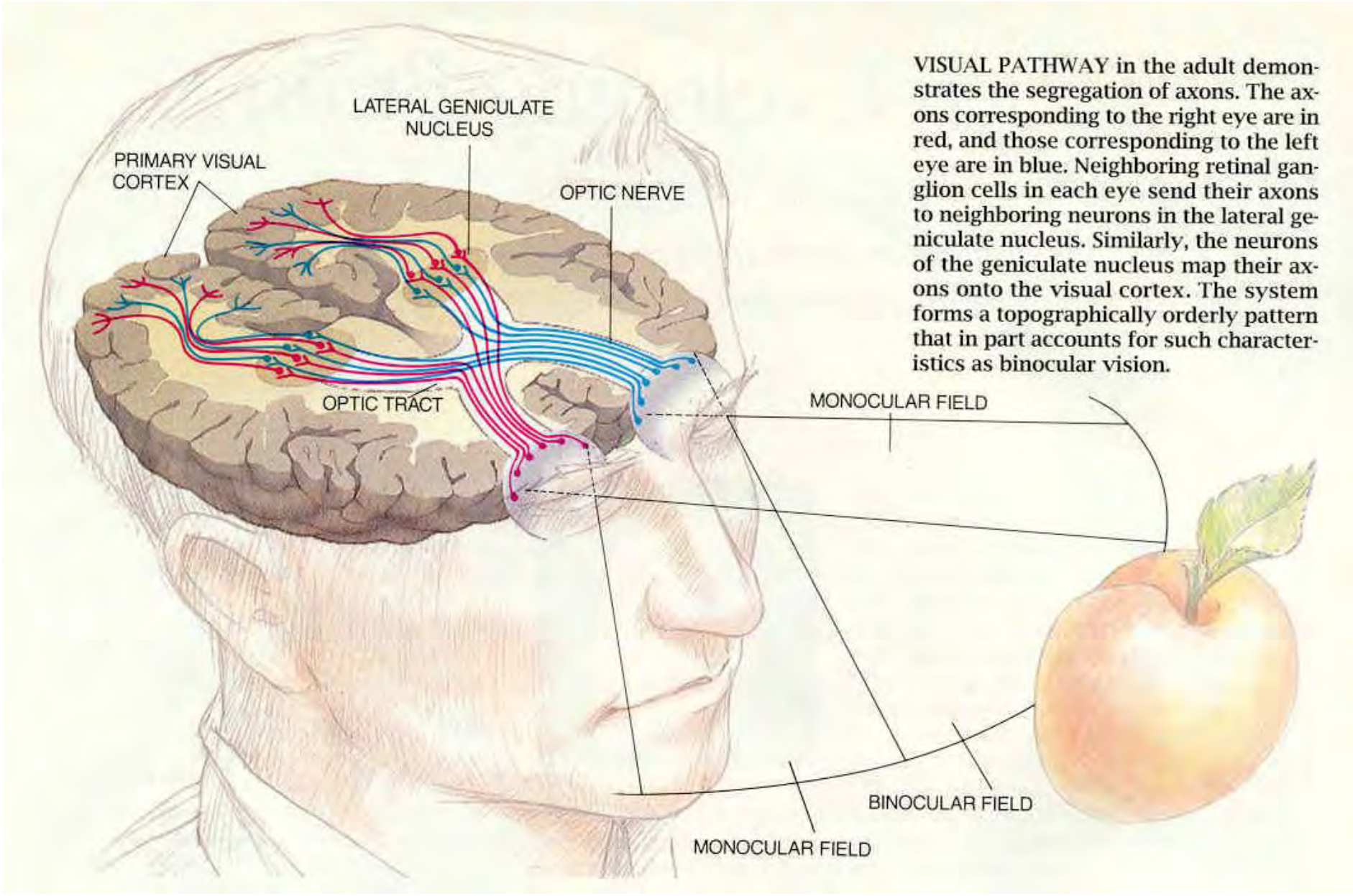
Light travels from our eye to our Brain

Optic nerve

- Made up of axons of ganglion cells, it carries neural messages from each eye to the brain

Optic chiasm

- Point where part of each optic nerve crosses to the other side of the brain



VISUAL PATHWAY in the adult demonstrates the segregation of axons. The axons corresponding to the right eye are in red, and those corresponding to the left eye are in blue. Neighboring retinal ganglion cells in each eye send their axons to neighboring neurons in the lateral geniculate nucleus. Similarly, the neurons of the geniculate nucleus map their axons onto the visual cortex. The system forms a topographically orderly pattern that in part accounts for such characteristics as binocular vision.

The Ear Uses Bones and Fluid to Transform Sound Waves into Sound Signals

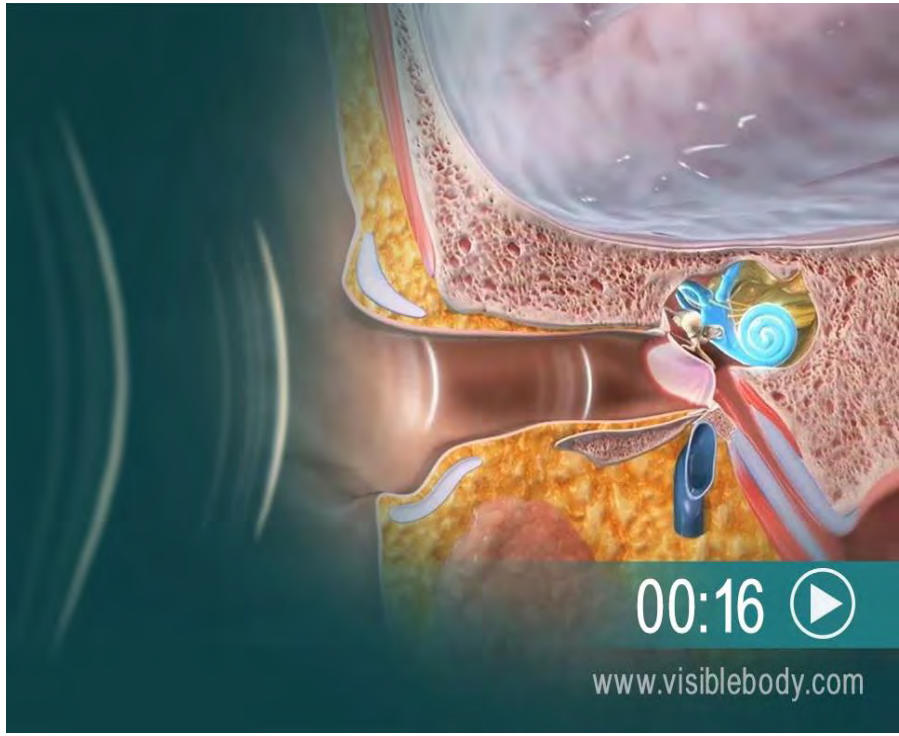
The outer ear funnels the waves down the ear canal (the external acoustic meatus) to the tympanic membrane (the “ear drum”).

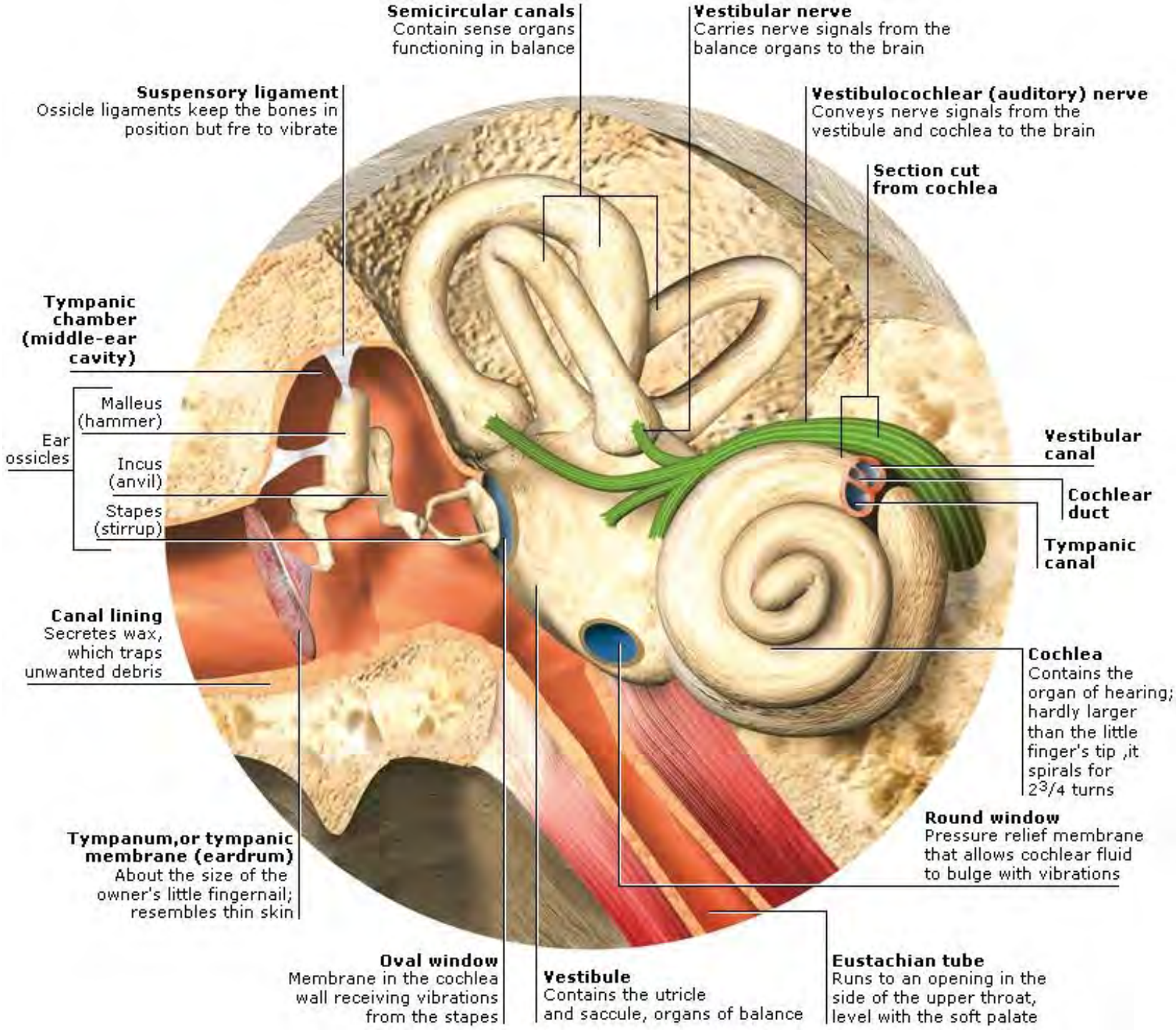
The tympanic membrane transfers these vibrations to three small bones, known as auditory ossicles, found in the air-filled cavity of the middle ear.

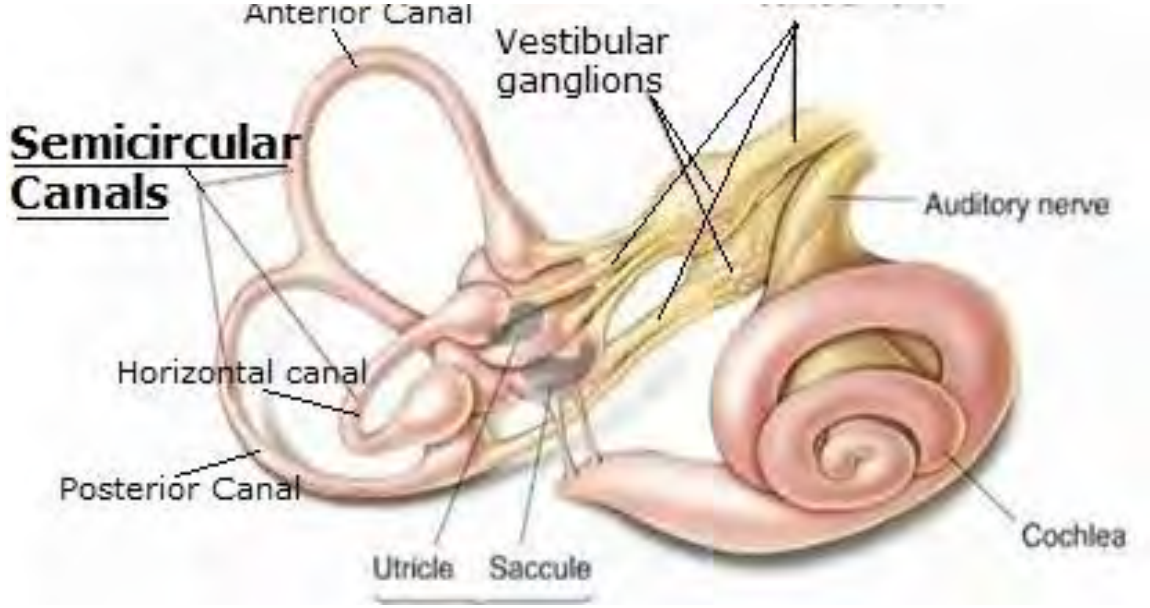
These bones – the malleus, incus, and stapes – carry the vibrations and knock against the opening to the inner ear.

The inner ear consists of fluid-filled canals, including the spiral-shaped cochlea. As the ossicles pound away, specialized hair cells in the cochlea, detect pressure waves in the fluid.

They activate nervous receptors, sending signals through the cochlear nerve toward the brain, which interprets the signals as sounds.




Semicircular canals
Contain sense organs functioning in balance
Vestibular nerve
Carries nerve signals from the balance organs to the brain
Suspensory ligament
Ossicle ligaments keep the bones in position but fre to vibrate
Vestibulocochlear (auditory) nerve
Conveys nerve signals from the vestibule and cochlea to the brain
Section cut from cochlea
Tympanic chamber (middle-ear cavity)
Ear ossicles
Malleus (hammer)
Incus (anvil)
Stapes (stirrup)
Vestibular canal
Cochlear duct
Tympanic canal
Canal lining
Secretes wax, which traps unwanted debris
Cochlea
Contains the organ of hearing; hardly larger than the little finger's tip ,it spirals for $2\frac{3}{4}$ turns
Round window
Pressure relief membrane that allows cochlear fluid to bulge with vibrations
Tympanum,or tympanic membrane (eardrum)
About the size of the owner's little fingernail; resembles thin skin
Oval window
Membrane in the cochlea wall receiving vibrations from the stapes
Vestibule
Contains the utricle and saccule, organs of balance
Eustachian tube
Runs to an opening in the side of the upper throat, level with the soft palate



To help with our Balance, the Anterior, Posterior, and lateral (horizontal) semi-circular ducts (tubes) are arranged at right angles to each other so they represent all 3 planes in space – X, Y, and Z.

https://www.youtube.com/watch?v=eQEaiZ2j9oc

https://www.youtube.com/watch?v=YMIMvBa8XGs

Specialized Receptors in the Skin Send Touch Signals to the Brain

Skin consists of three major tissue layers: the outer epidermis, middle dermis, and inner hypodermis.

Specialized receptor cells within these layers detect tactile sensations and relay signals through peripheral nerves toward the brain.

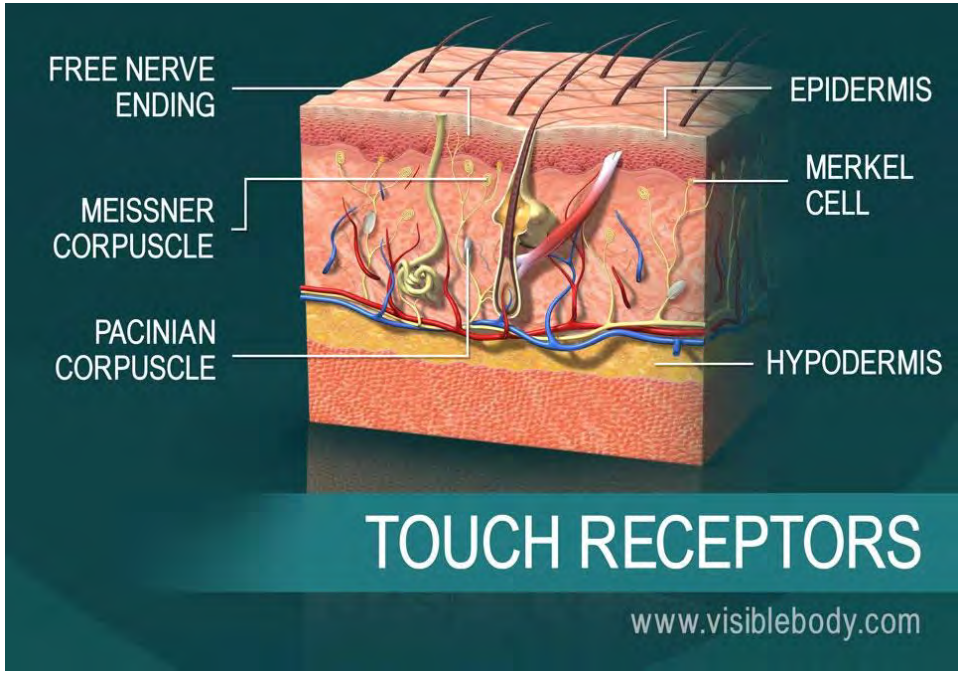
The presence and location of the different types of receptors make certain body parts more sensitive.

Merkel cells, for example, are found in the lower epidermis of lips, hands, and external genitalia.

Meissner corpuscles are found in the upper dermis of hairless skin — fingertips, nipples, the soles of the feet.

Both of these receptors detect touch, pressure, and vibration.

Other touch receptors include Pacinian corpuscles, which also register pressure and vibration, and the free endings of specialized nerves that feel pain, itch, and tickle.



PROPRIOCEPTORS

Proprioceptors (sometimes, also called mechanoreceptors), provide us with information about the effects of our surroundings on our bodies as well as giving us a continuous understanding of the position and movement of our body and its parts.

The many thousands of nerve connections to the brain, allow it to create a 3 dimensional shape of the body to know what is going on with the physical location of it's parts. All of the sensors operate by producing an electrochemical signal that is unique to each type of cell which goes to the brain for analysis.

As shown in the illustrations on the next 2 pages, the Proprioceptors are divided into 4 main types:

A. Two types that are under our skin, called Cutaneous which give us information about our environment through touch or feeling.

B. 2 types of free nerve endings that give us Nocloception for sensing pain and temperature.

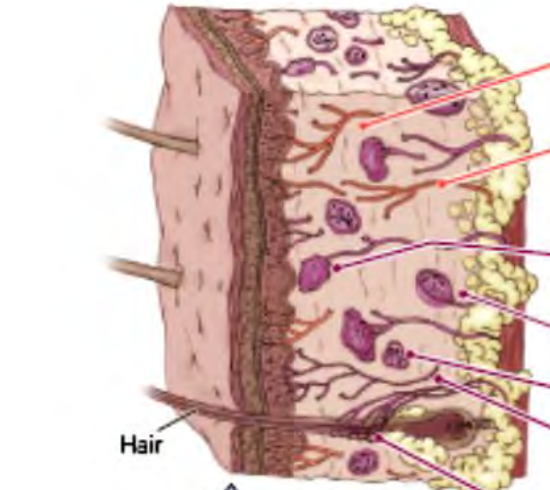
C. 6 types of cells under the skin that provide Hapsis for sensing different levels of touch and pressure, which includes free nerve endings.

D) A 4th type of Proprioceptor in the main areas of our bodies, that consists of 3 types of cells that sense body part location, movement, and awareness

Cells in muscle spindles that sense the direction and amount of muscle stretch

Golgi tendon cells which are in the tendons at the ends of each main muscle where they connect to the bone, to provide a measure of how much the tendon is stretching.

Cells at each joint where the bones connect to each other with ligaments, to know the amount and direction of each joint movement.

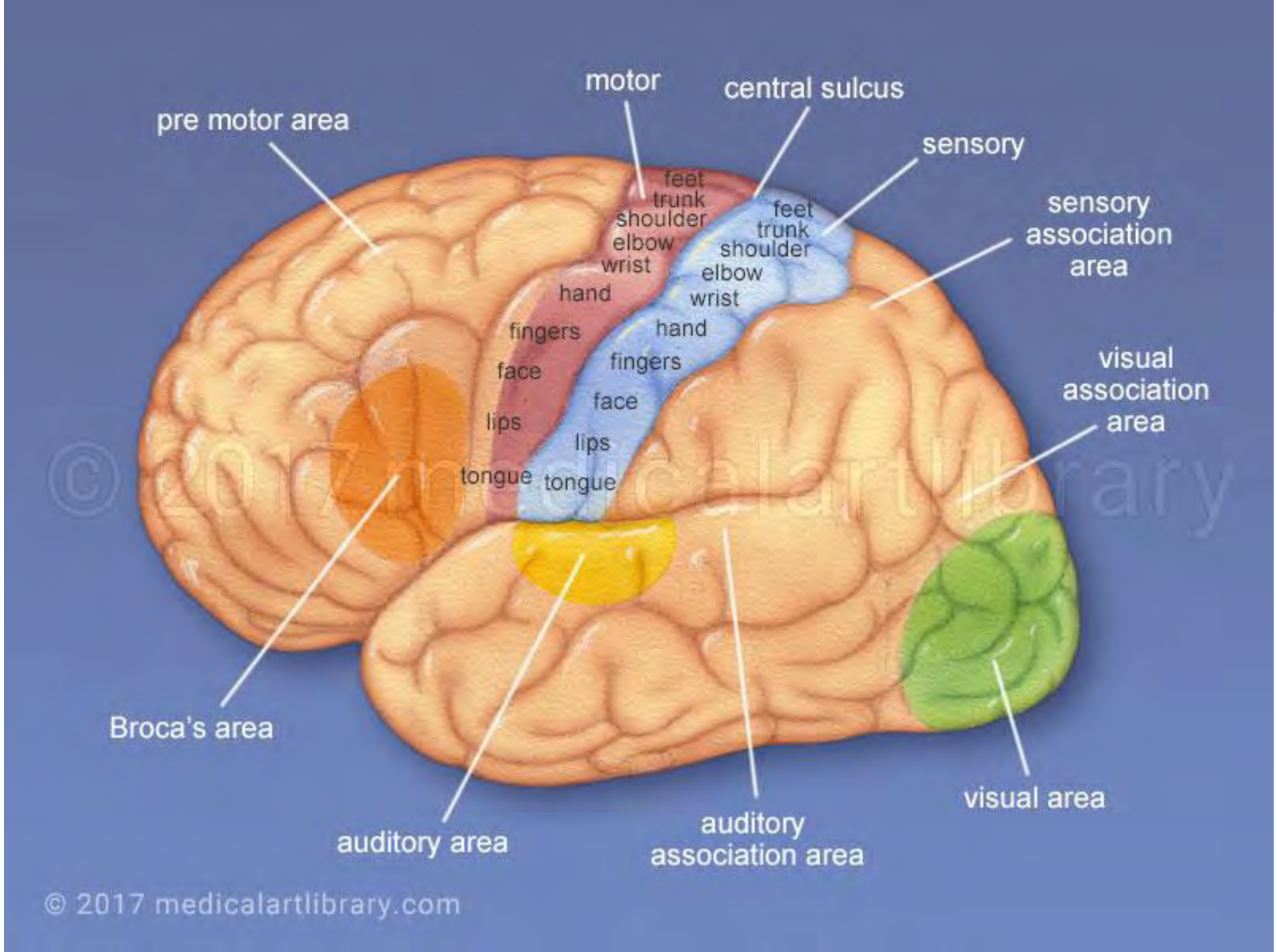


Nocioception (pain and temperature)	Adaptation	
Free nerve endings for pain (sharp pain and dull pain)	Slow	Damage to the dendrite or to surrounding cells releases chemicals that stimulate the dendrite to produce action potentials.
Free nerve endings for temperature (heat or coldness)	Slow	

Hapsis (fine touch and pressure)	Adaptation	
Meissner's corpuscle (touch)	Rapid	Pressure on the various types of tissue capsules mechanically stimulates the dendrites within them to produce action potentials.
Pacinian corpuscle (flutter)	Rapid	
Ruffini corpuscle (vibration)	Rapid	
Merkel's receptor (steady skin indentation)	Slow	
Hair receptors (flutter or steady skin indentation)	Slow	

Proprioception (body awareness)	Adaptation	
Muscle spindles (muscle stretch)	Rapid	Movements stretch the receptors to mechanically stimulate the dendrites within them to produce action potentials.
Golgi tendon organs (tendon stretch)	Rapid	
Joint receptors (joint movement)	Rapid	

Figure 10-16


motor
central sulcus
pre motor area
sensory
sensory association area
visual association area
feet
trunk
shoulder
elbow
wrist
hand
fingers
face
lips
tongue
Broca's area
auditory area
auditory association area
visual area
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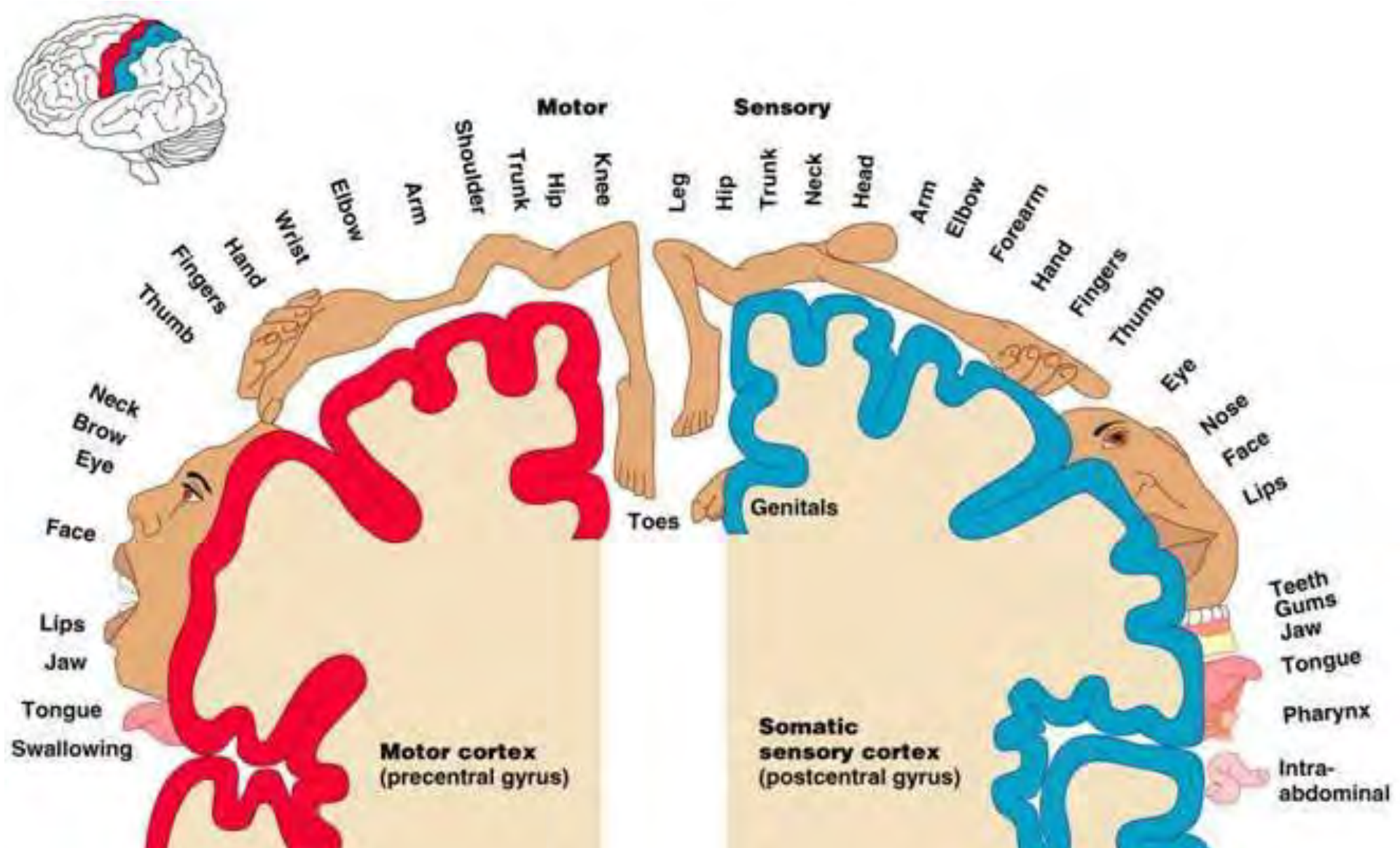
Extra large areas of the brain are devoted to the hands, face and feet.

This diagram and the ones on the next set of pages, are intended to give an image of how much area of the Cortex controls or receives information to and from these areas.



As an interesting view of how the different parts of the brain interact with parts of the body, persons have developed several visual views of how much of the nerve parts of the brain are devoted to those parts.

The 3-dimensional view to the right, gives a great visual comparison of how much of the brain is focused on the important parts of our body.

It is called a homunculus which means “little man”.

Inside the cortex

We know that different areas of the cortex control different parts of the body. Scientists can say *how much* of the cortex relates to each part of the body, as this exhibit shows.

sensory

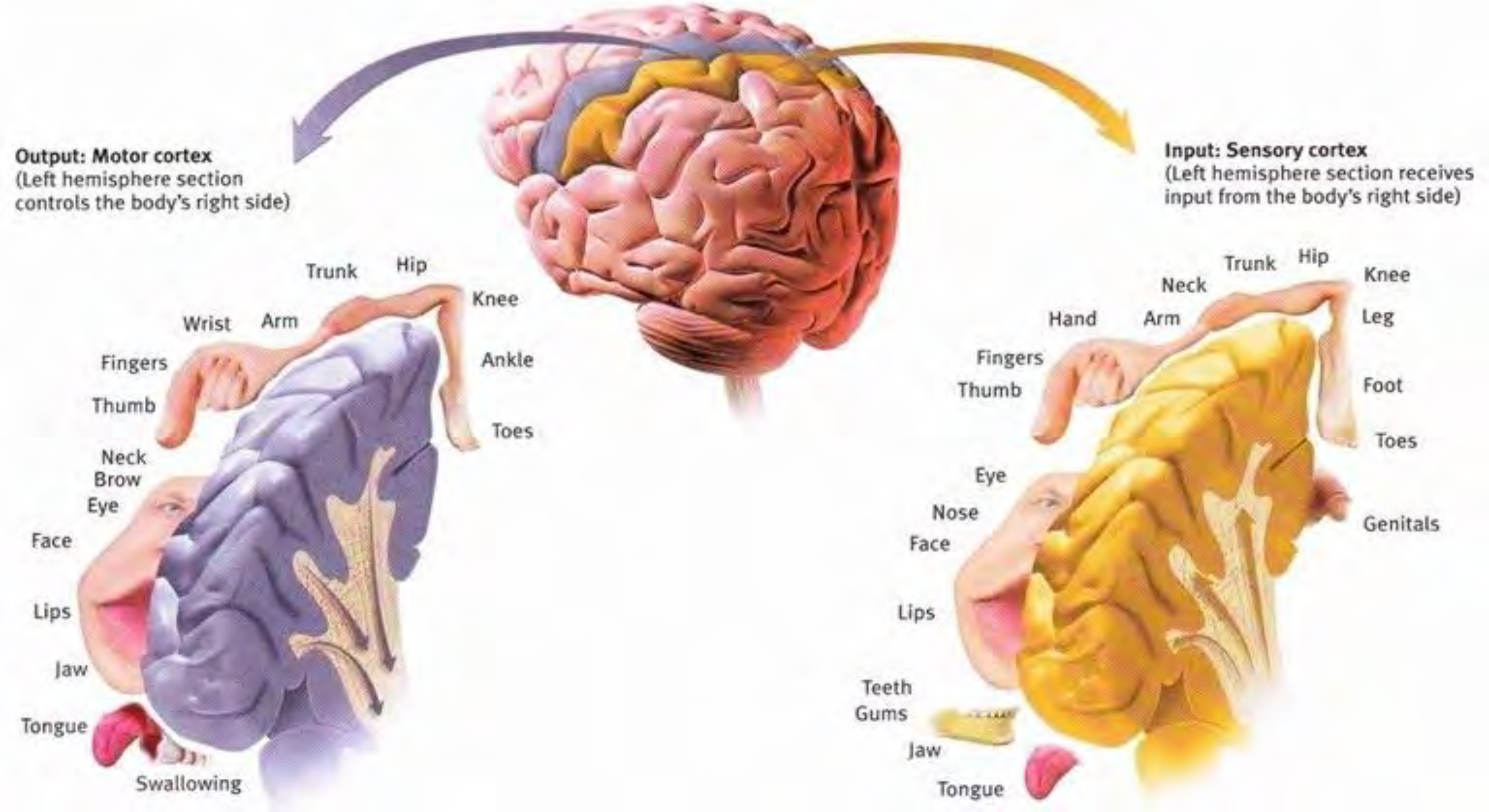
motor

'Cortex man'
(representational models)

This is what a man would look like, if each part of his body grew in relation to the area of the cortex that controls it.

Sensory model

Motor model


Output: Motor cortex
(Left hemisphere section controls the body's right side)
Trunk
Hip
Knee
Wrist
Arm
Fingers
Thumb
Ankle
Toes
Neck
Brow
Eye
Face
Lips
Jaw
Tongue
Swallowing
Input: Sensory cortex
(Left hemisphere section receives input from the body's right side)
Trunk
Hip
Knee
Neck
Hand
Arm
Leg
Fingers
Thumb
Foot
Toes
Eye
Nose
Face
Genitals
Lips
Teeth
Gums
Jaw
Tongue

Olfaction: Chemicals in the Air Stimulate Signals the Brain Interprets as Smells

The sense of smell is called olfaction.

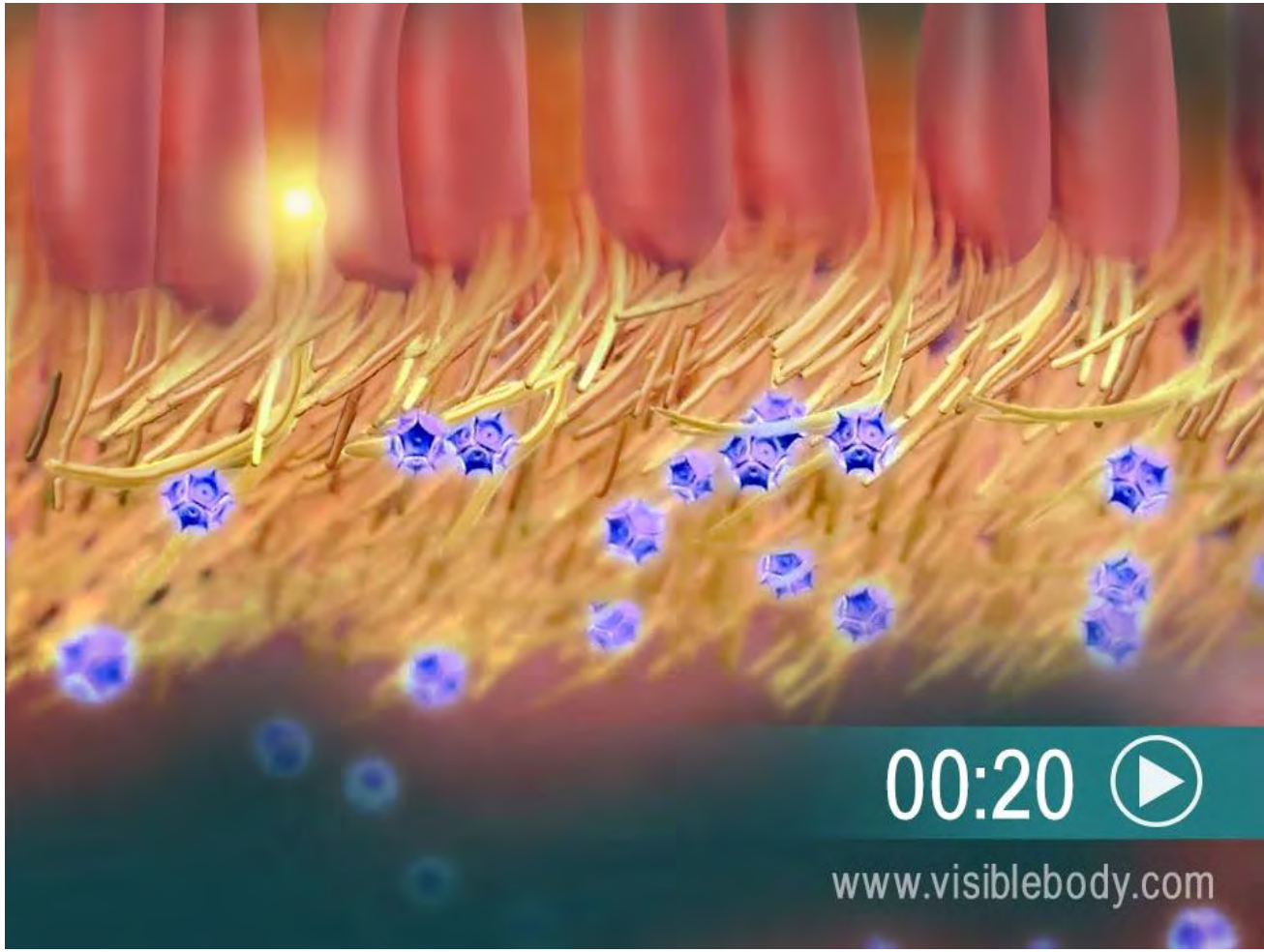
It starts with specialized nerve receptors located on hair-like cilia in the epithelium at the top of the nasal cavity.

When we sniff or inhale through the nose, some chemicals in the air bind to these receptors.

That triggers a signal that travels up a nerve fiber, through the epithelium and the skull bone above, to the olfactory bulbs.

The olfactory bulbs contain neuron cell bodies that transmit information along the cranial nerves, which are extensions of the olfactory bulbs.

They send the signal down the olfactory nerves, toward the olfactory area of the cerebral cortex.



Home of the Taste Buds: The Tongue Is the Principal Organ of Gustation

What are all those small bumps on the top of the tongue? They're called papillae.

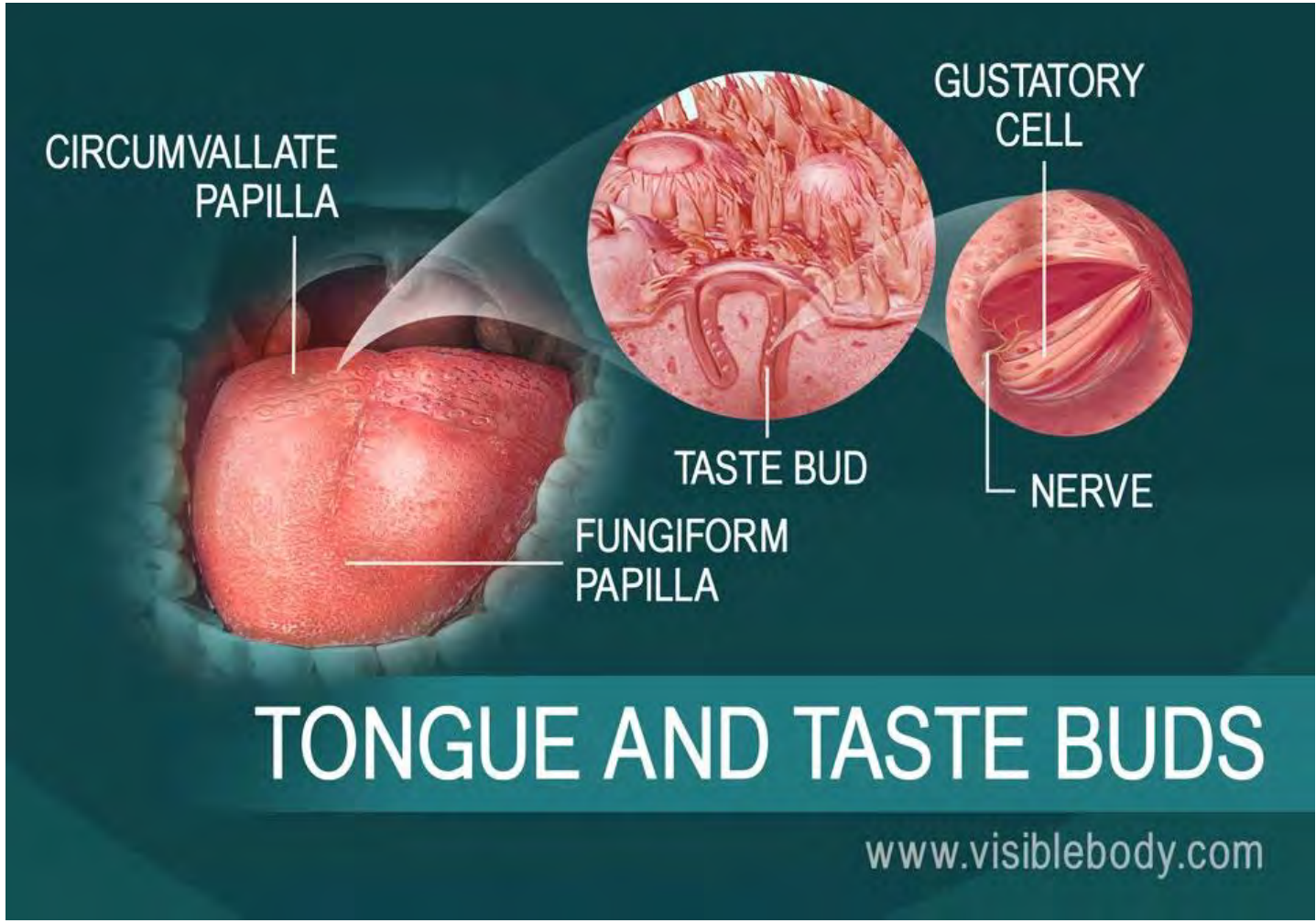
Many of them, including circumvallate papillae and fungiform papillae, contain taste buds.

When we eat, chemicals from food enter the papillae and reach the taste buds.

These chemicals (or tastants) stimulate specialized gustatory cells inside the taste buds, activating nervous receptors.

The receptors send signals to fibers of the facial, glossopharyngeal, and vagus nerves.

Those nerves carry the signals to the medulla oblongata, which relays them to the thalamus and cerebral cortex of the brain.



Taste

Four primary tastes:

1	Bitter	Detected by back of tongue
2	Sweet	Detected by tongue tip
3	Sour	Detected by sides of tongue
4	Salt	Detected by tip and side of tongue

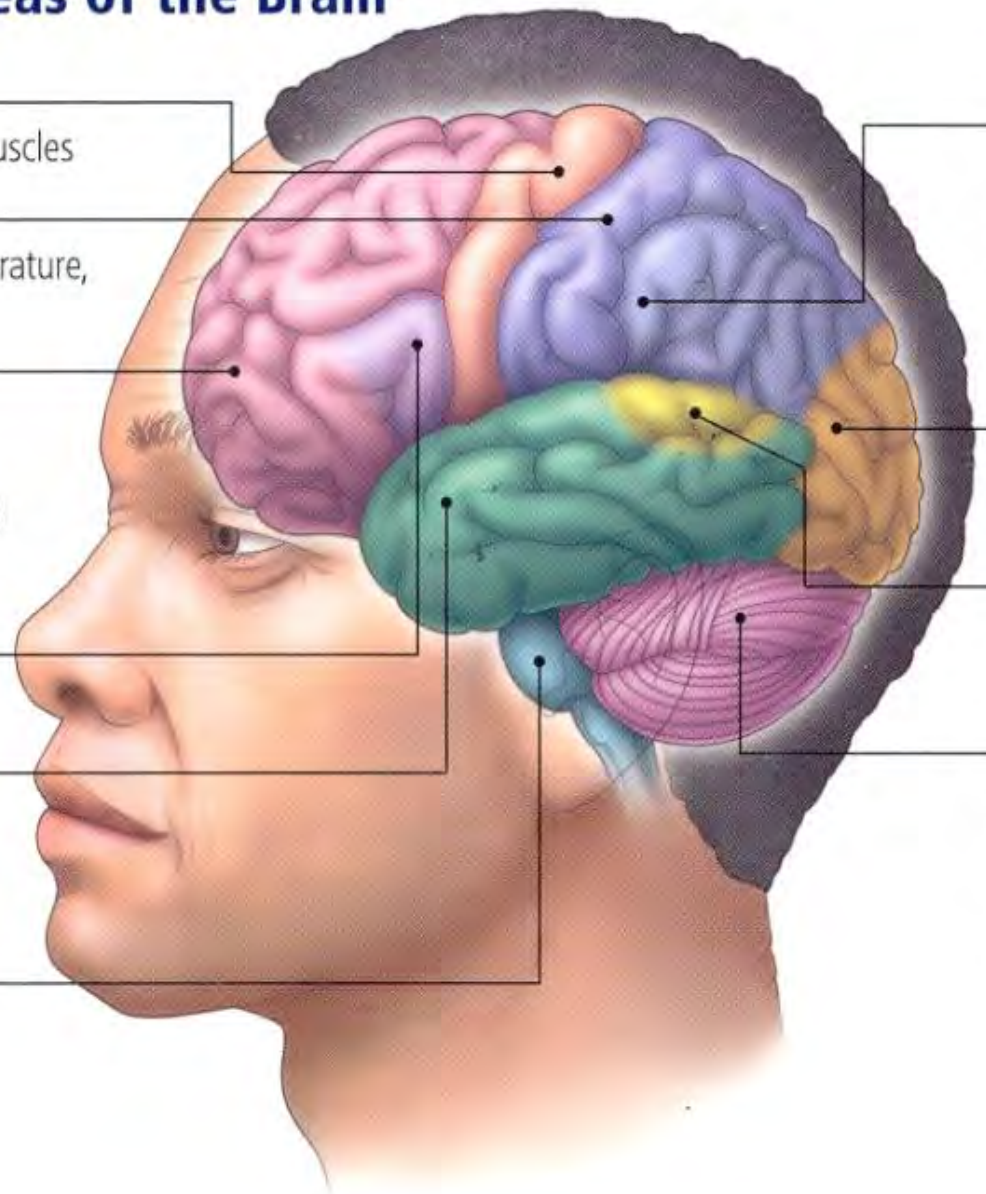
Taste blindness is inherited by some people for certain substances.

Threshold of taste: One teaspoon of sugar in two gallons of water.

A 5th taste has been discovered which is called Umami.

It is a taste similar to that of eating foods with a small amount of Monosodium Glutamate (MSG) in it.

Functional Areas of the Brain[1]



Motor Area
- control of voluntary muscles

Sensory Area
- skin sensations (temperature, pressure, pain)

Frontal Lobe
- movement
- problem solving
- concentrating, thinking
- behaviour, personality, mood

Broca's Area
- speech control

Temporal Lobe
- hearing
- language
- memory

Brain Stem
- consciousness
- breathing
- heart rate

Parietal Lobe
- sensations
- language
- perception
- body awareness
- attention

Occipital Lobe
- vision
- perception

Wernicke's Area
- language comprehension

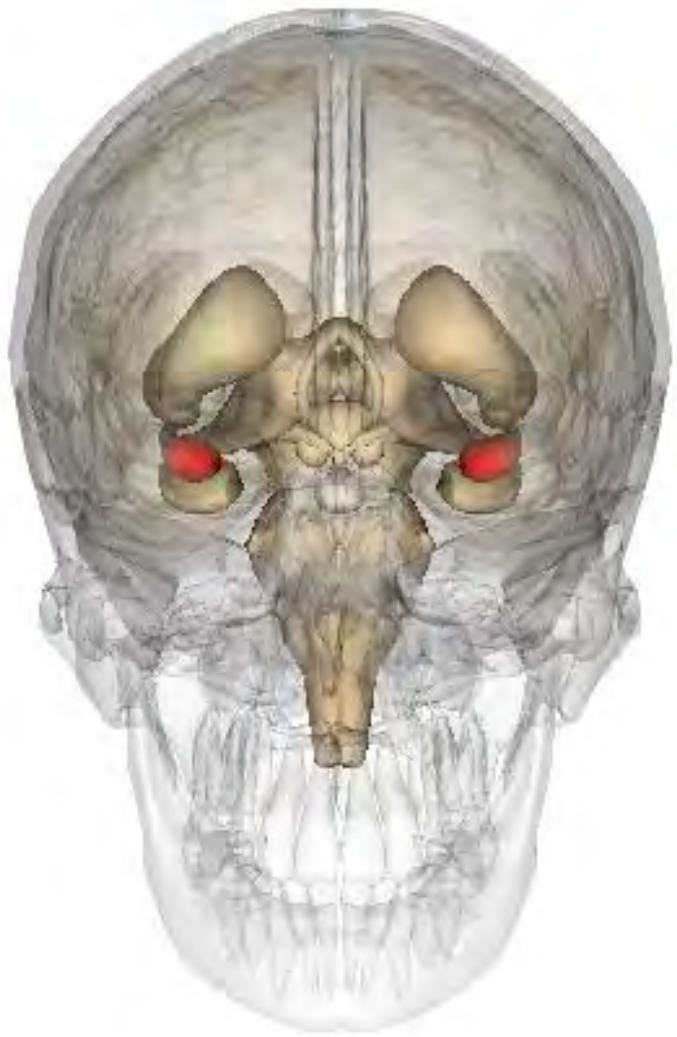
Cerebellum
- posture
- balance
- coordination of movement

The Amygdala are the red spots shown at right and are responsible for the recognition of fear and negative emotions as well as facial recognition.

Facial expression is one or more motions or positions of the muscles beneath the skin of the face.

These movements convey the emotional state of an individual to observers and are a form of nonverbal communication.

They are a primary means of conveying social information between humans.



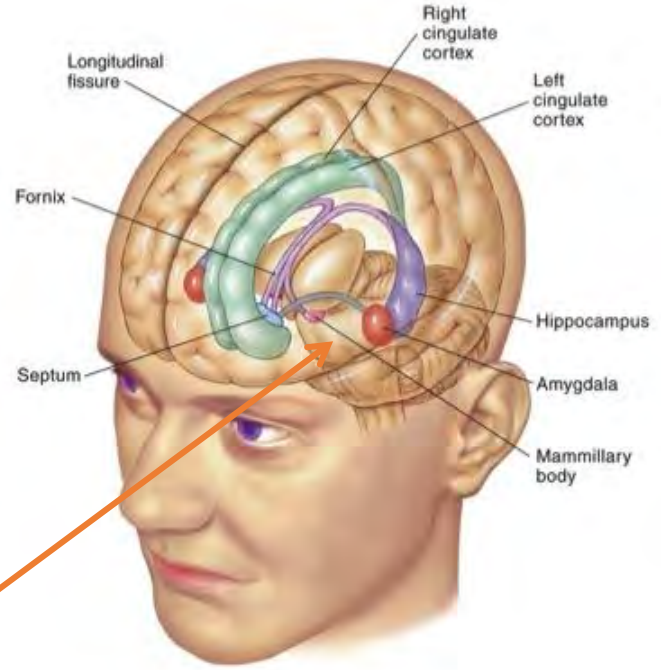
WHY DO OUR EMOTIONS CHANGE WHEN WE BECOME A TEENAGER ?

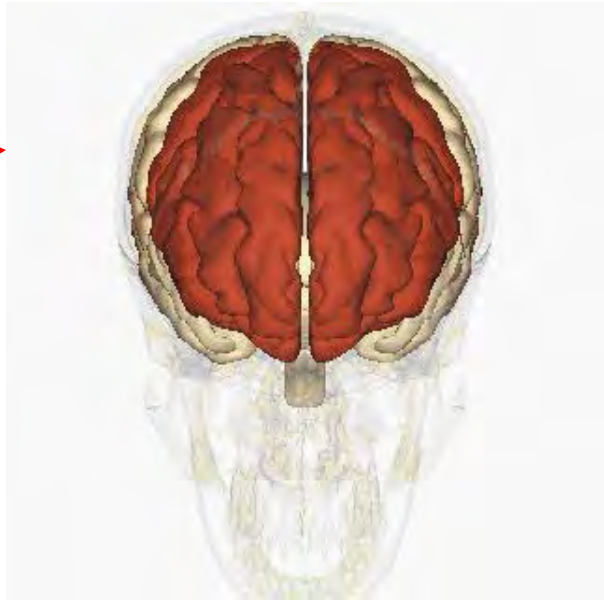
Adolescents differ from adults in the way they behave, solve problems, and make decisions. There is a biological explanation for this.

New findings show that the greatest changes to the parts of the brain that are responsible for functions such as self-control, judgment, emotions, and organization occur between puberty in the teen years and even into their 20's.

Scientists have identified a specific region of the brain called the amygdala (shown in red, above) which is responsible for instinctual reactions including fear and aggressive behavior. This region develops early.

However, the frontal cortex, the area of the brain that controls reasoning and helps us think before we act, develops later. This part of the brain is still changing and maturing well into adulthood.





Teens also differ from adults in their ability to read and understand emotions in the faces of others.

Recent research shows that teens and adults actually use different regions of the brain in responding to certain tasks.

During medical testing, teens often misread facial expressions, with those under the age of 14 more often seeing sadness or anger or confusion instead of fear.

Older teenagers answered correctly more often and exhibited a progressive shift of activity from the amygdala to the frontal lobes.

THANK EWE!
THANKS!